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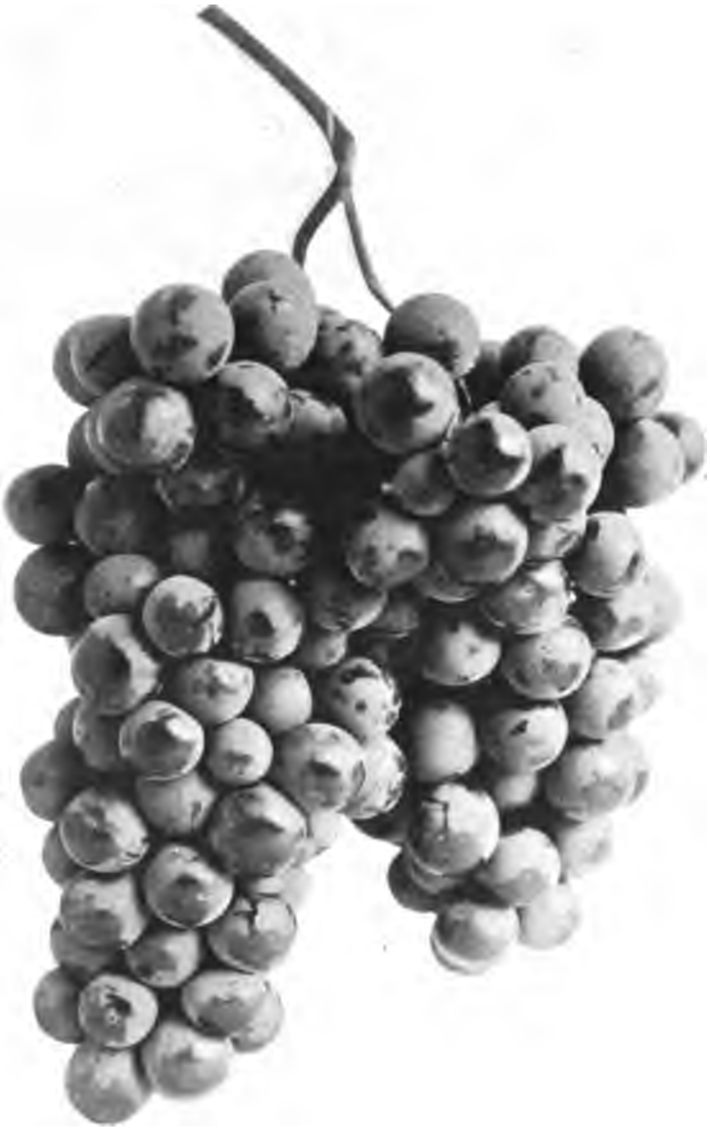
OF 1858 ✣ LEFT THE LAW
SCHOOL AT THE OUTBREAK
OF THE CIVIL WAR TO JOIN
THE 20TH MASSACHUSETTS
VOLUNTEER INFANTRY
MORTALLY WOUNDED AT
THE BATTLE OF GLENDALE
JULY 30TH 1862

FROM THE GIFT OF HIS SISTER
HARRIET LOWELL PUTNAM
M·CM·XVII

The

Encyclopedia of Practical Horticulture



Roumania.

—*Maxted Photo*

The

Encyclopedia of Practical Horticulture

A Reference System of Commercial Horticulture

Covering the Practical and Scientific
Phases of Horticulture with Special
Reference to Fruits and Vegetables

Editor-in-Chief
GRANVILLE LOWTHER
Associate Editor
WILLIAM WORTHINGTON
Assisted by the best known scientific and practical horticulturists
throughout the country, and particularly in the Northwest . . .

Illustrated

Volume II

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W. M. FLEMING, President
NORTH YAKIMA, WASHINGTON, U. S. A

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the frosts of early winter, sometimes working as late as the end of October. The number of eggs deposited by a single female exceeds 100, and possibly 200. The eggs remain unchanged, or dormant, in the twigs until the following spring, hatching in May or early in June. * * *

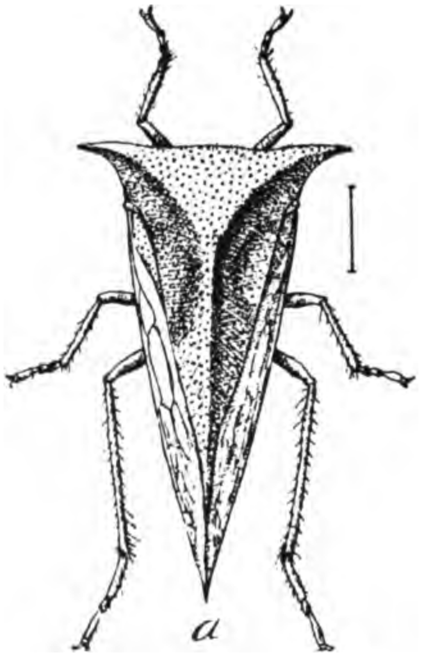

Fig. 1. The Buffalo Tree Hopper: Female—enlarged. (After Marlatt.)

The eggs of the buffalo tree hopper are subject to the attacks of at least two minute egg parasites, which often do much to keep the insect in check

In general characteristics the larvae and nymphs resemble the adults, but are wingless and covered along the center dorsally with numerous forked or barbed projections.

Food Plants

All kinds of succulent plants such as weeds and garden vegetables are fed upon, but in this respect the insect is not a serious pest.

Remedies

The destruction of the insects themselves is hardly practical. By limiting the amount of unnecessary vegetation in and about nurseries and orchards, a great deal can be done toward keeping down the insect in the larval and pupal stages. Pruning out and burning the infested twigs will also materially decrease their numbers. Clean cultivation will probably do more than all other precautions.

Canker Worm

Notolopus sp.

H. F. Wilson

In the early spring, after the apple leaf buds have opened, we often find numbers of little darkish colored measuring worms, which feed on the leaves. These are called canker worms and are apparently different from our Eastern canker worms. The eggs of this insect are deposited on the trunks and leaves and hatch in the spring. When first hatched the larvae are very small and such feeding as they do is not apparent. As they increase in size the entire leaf, with the exception of the midrib and larger veins, is devoured. About four weeks after hatching the larvae are full fed and then drop to the ground, enter to a depth of a few inches and pupate. They remain here until late fall or early spring, when they change to the adult insect. The eggs are deposited in masses by wingless moths of sluggish appearance that gradually crawl up a small twig, depositing the eggs as they move forward.

The female moth is brownish in color with a slight tinge of gray and measures about three-fourths inch in length. The male moth has not been observed. As the female moth is unable to fly, this species is distributed very slowly, and since the larvae readily succumb to arsenical poisons, there is very little chance for this pest to ever become very serious.

The same remark would apply to the fall canker worms.

Casebearers

Coleophora fletcherella

C. malivorella

The cigar casebearer (*Coleophora fletcherella*) and the pistol casebearer (*C. malivorella*), so named from the shape of their cases, are insects which may do a considerable amount of injury but which may be controlled by spraying properly. The adults are moths measuring about one-half inch from tip to tip of the wings. The larvae hibernate in cases attached to twigs. In spring they feed on the opening buds and the new foliage till full grown, living all the time in cases which are readily seen projecting from the surface of the bud or leaf. They also attack the flowers and fruit. The casebearers are distributed from Nova Scotia westward to the Mississippi and southward. They are held in check by a minute parasite.

Treatment

Spray with kerosene emulsion or Paris green early in spring before the leaf buds are opening. Orchards regularly treated for codling moth will not be troubled.

CATERPILLARS. See *Tent Caterpillar, Red Humped Caterpillar.*

Cecropia Moth

Samia cecropia

This is the largest caterpillar and moth occurring in the United States. The caterpillar measures, when grown, in the neighborhood of four inches in length and bears along the back blunt tubercles, some red, some yellow, some blue. Some of the larger moths have a wing expanse of seven inches.

The magnificent moth of this insect is so striking in size and colors that most people who have lived in the country or in villages have at some time had their attention arrested by it. The larvae is not less striking, but its green colors are so like those of the leaves that it is not often seen, unless several of them should denude a small tree or two in a dooryard. I have known a couple of the ravenous fellows to clear the leaves from a young apple tree pretty completely.

The pupa stage is passed in a large reddish gray cocoon, consisting of tough layers, the outer one separated by a layer of loose silk from an inner oval, completely closed over surrounding the pupa. Not important. H. GARMAN,

Lexington, Ky.

Climbing Cutworms

(Various species)

Sometimes the expanding buds of apple and other fruit trees are eaten into and destroyed, yet no destructive agent is in evidence to account for the damage. Some parts of the tree fail to leaf out, or the young leaves on an entire branch suddenly disappear. Some of the blossoms are found to have a hole cut through the side of the calyx and the ovary consumed. Such damage is usually indicative of the work of climbing cutworms which feed at night. Several different species work such injury. Banding the trees as for canker worms, with sticky materials, cotton batting or tin collars is perhaps the most reliable measure. Poisoned bran mash used in conjunction with banding is very effective. Where early spraying is done for the bud worms and casebearers or canker worms, probably no other measure will be needed.

H. A. GOSSARD,

Wooster, Ohio.

Codling Moth

Carpocapsa pomonella Linn.

By H. F. WILSON

The codling moth must everywhere be considered an important factor in apple, and to a less extent, in pear growing. It occurs in every important apple growing section of the world, and wherever repressive measures are not employed, annually destroys one-fourth or more of the crop.

Supposed Immune Regions—The above statement is made notwithstanding the repeated appearance of reports of new or little developed fruit regions which, by reason of some especially favorable soil or climatic condition, are supposed to be immune.

Orchardists who are located, or who contemplate locating in such supposed favored regions are cautioned against relying too implicitly upon the continued absence of the codling moth, unless active, intelligent effort, rather than blind reliance upon an unknown factor, be made to prevent its gaining a good foothold. During the past fifteen years we have seen this idea of immunity dispelled in locality after locality in the Pacific Northwest, and when we consider that the codling moth is a serious pest in England, on the continent of Europe from Mediterranean regions to the northern limits of apple growing in Siberia, in Southern Africa, Australia, New Zealand, Tasmania and China, as well as in the United States and Canada, we are forced to recognize the improbability of perpetually immune regions. Once it gains a foothold the codling moth will thrive wherever the apple can be grown successfully.

We do not wish to be understood as arguing that the codling moth will become equally destructive in all localities, or that its prevalence is independent of climatic conditions. Rather the contrary is true, since the seriousness of its depredations varies with both the locality and the season. Temperature is the great factor which controls the abundance of a species in a given locality; hence, as the female moth deposits eggs freely only when the evening temperature is above 60 degrees Fahrenheit, we should expect to find, as indeed we do find, that the orchards in the coast regions west of the Cascades, and those of the inland plateau sections, are less subject to the ravages of the codling moth than those of the inland valleys. This factor is of but little practical importance, however, and should be given scant consideration in the selection of an orchard site. The probability is that as orchards become more numerous, active repressive measures against the codling moth will become necessary, even in the most favored localities.

Know All Stages—Efficient spraying operations and the proper application of other repressive measures against the codling moth are so intimately linked with its habits, and these habits so varying, within certain limits, with the locality and the season, that every grower should become familiar with it in all of its stages. Unfortunately, however, growers do not seem fully to recognize the importance of such information, or consider it too technical and difficult to obtain. Consequently few actually do know it in any other than the larval or "worm" stage, notwithstanding the fact that a "speaking acquaintance" with all stages is easily acquired.

The codling moth, in common with many other insects, passes through four sharply defined stages during its development, viz.: the egg, the larva or "worm," the pupa, and the moth or adult. All four stages from the egg to the moth inclusive constitute a generation or a "brood," and since this cycle from egg to moth is completed twice during the year, the insect is said to pass through two generations yearly, or to be "two brooded." In some of the warmer apple growing sections of the South three broods are reported. During the winter it exists only in the larval state, but during a greater portion of the summer months it may be found in all four stages.

The Egg—The eggs, which are laid singly, are minute, nearly circular scale-like objects about one-twentieth of an inch in diameter, pearly white in color and somewhat translucent. They may well be likened to minute trout scales glued to the surface of a leaf or fruit. The surface of the egg, however, is finely wrinkled and so reflects the light that it appears as a minute glistening speck, if the fruit or leaf to which it is attached is held at the correct angle before the eye. In two to four days after oviposition the developing larva becomes distinctly visible as a black spot near the center of this circle and the outline of the whole body is discernible for a day or two before the egg hatches. The eggs hatch in from seven to ten days.

The Larva—When first hatched the young larva is scarcely one-sixteenth of an inch long. The head is large, black and shining; the body is slender, translucent white in color and marked with distinct black spots, each of which has a minute bristle. Owing to their minute size and to the fact that they usually enter the fruit very soon after hatching, these young larvae are rarely seen. As the larva develops it molts five times; the color of the head and the thoracic and anal shields turn black to brown, and the body acquires a pinkish tinge. The full-grown larva is about three-fourths of an inch long and one-twelfth of an inch in diameter. The duration of the larval stage is from sixteen to twenty-four days.

The Pupa—Shortly after becoming full grown the larva leaves the apple and seeks some protected spot in which to hide while passing through its transformations from larva to pupa, then to moth. Having found a suitable place, it hollows out a little oval cavity with its jaws and proceeds to envelop itself in a thin tough cocoon of silken threads intermingled with particles of the excavated material. When completed, the cocoon is usually oval in form and about three-fourths of an inch long. When the pupal stage is reached the insect remains in that stage for about three weeks, and then emerges as the adult or moth.

The Moth or Adult—The moths are really beautiful little creatures. The body is about three-eighths of an inch long and is of a modest greyish brown color. The fore wings when fully expanded measure about three-fourths of an inch from tip to tip and are of approximately the same color as the body but relieved by inconspicuous, transverse wavy lines or lighter scales. The hind wings which are entirely covered when the insect is at rest are nearly slate colored and are clothed with long hairs. The most characteristic marking is a large golden brown spot at the posterior outer angle of each front wing. No other insect is known which has this marking and no insect need be mistaken for the codling moth. The males are further distinguished by a narrow pencil of black hairs on the hind wings and an elongated black spot on the upper surface of each front wing.

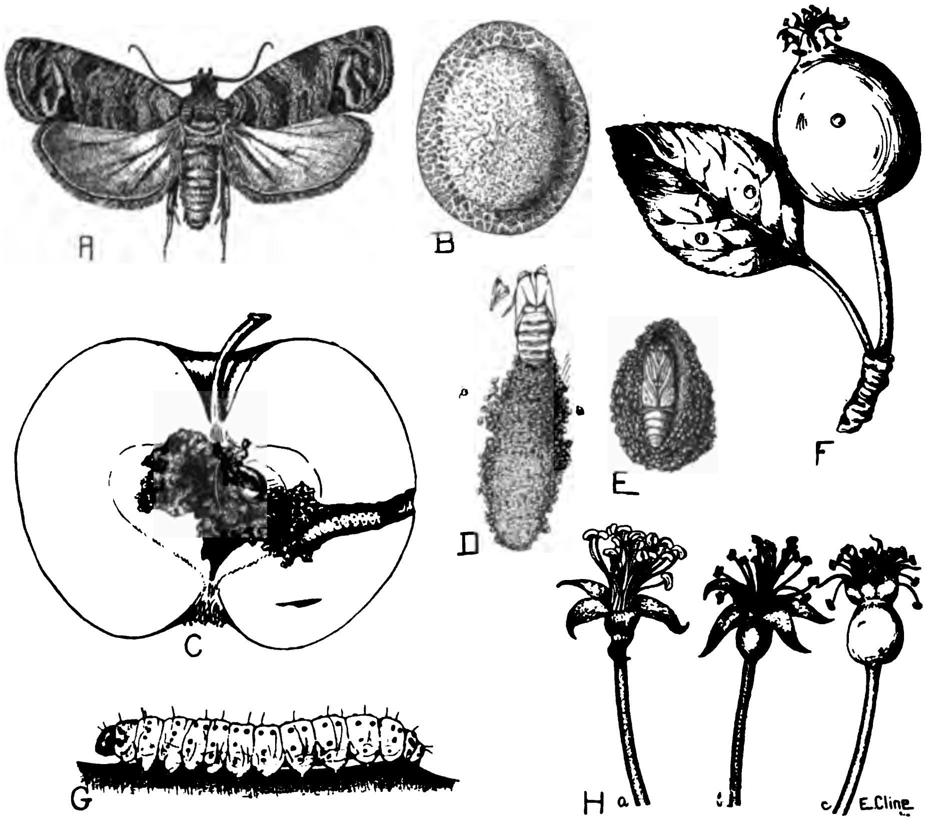

Fig. 1. Codling moth. A, adult moth with wings expanded; B, egg much enlarged; C, half of worm-eaten apple; D, cocoon with empty pupa shell protruding; E, cocoon with pupa enclosed; F, leaf and apple showing eggs of a codling moth; G, caterpillar or "apple worm" enlarged; H, a, young apple just after petals fall; b, cup beginning to close; c, too late to spray. (Montana Experiment Station.)

Owing to their coloring, which resembles closely that of the bark upon which they often rest, and their habit of remaining quiet during the daytime, these moths can very rarely be detected in the orchard. Occasionally one may be seen flitting about the trees at twilight, and very rarely we have observed them resting quietly upon the bark and leaves and even on the ground. When disturbed they start away with a swift zig-zag motion very hard to follow. For the purpose of depositing eggs they normally fly only during the warm nights, and are presumably most active during the twilight period.

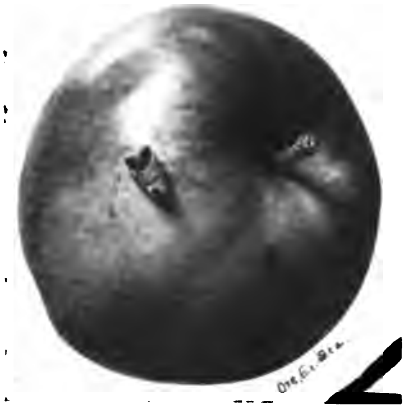

Fig. 2. Adult Resting on Apple.

Recommendations for Northwest

Conditions which are found in the Eastern states have but little bearing upon somewhat dissimilar conditions found in this section. Early spraying alone will not save the fruit, and it is not only practicable but necessary to fight the second brood. So far as the codling moth is concerned, early applications, after the calyx lobes close are of very little value in Western Oregon and Washington. In the orchard sections of those regions the petals fall from the first week in May to several weeks later in sections along the coast.

The first larvae enter the fruit at Corvallis, Oregon, rarely before June 25, so that a period of about six or seven weeks exists between the time of the calyx spray and the time when the larvae enter the fruit. This is in a great measure due probably to the fact that the eggs of the codling moth are not deposited until the evening temperatures reach 60 degrees Fahrenheit, or above.

At Roseburg, Oregon, the records of the U. S. Weather Bureau for the past ten years were examined and notes made as follows: After May 20, at dusk of each day the temperature is about 60 degrees Fahrenheit, or above. Beginning with June 1 the evening temperature, up to 12 o'clock, does not fall below 65 degrees Fahrenheit. At Roseburg, June 8, eggs, hatched and unhatched, were found with an occasional larva entering the fruit.

At Medford, Oregon, the larvae begin to work in the fruit about the same time.

Recommendations for Spraying in Northwest

Make at least three applications and in renovating old orchards a fourth will not do any harm.

1. In all sections spray immediately after the petals fall.
2. In all sections of Western Oregon and Washington it is not necessary to spray two weeks after the first application. Make the second application approximately six weeks after the calyx spray, and the third about five weeks after the second. Where a fourth application is deemed necessary, spray about three weeks after the third.
3. In sections of the Northwest, east of the Cascade mountains, spray from two to three weeks after the first application, depending upon the weather conditions. Make a third application five weeks after the second and a fourth two weeks later than the third.

Poisons To Be Used

Paris green, London purple, arsenate of lime, and arsenate of lead, are the principal arsenites which have been used for spraying. At present the last-named is practically the only one used. The principal brands upon the market at present are Bean's Ortho 13, Better Spray, Grasselli's Star, Lyons', Swift's, and Sherwin-Williams. These fall readily into two classes, viz.: the neutral ortho-arsenates and the acid arsenates. In those of the first group the ratio of lead oxide to arsenic oxide is approximately 3 to 1. In those of the second group the ratio is as 2 to 1. The neutral or ortho-arsenates are made by combining lead acetate and sodium arsenate; the acid arsenates by using lead nitrate in place of lead acetates. The insecticidal value of the various brands depends upon the actual amount of lead arsenate which is present.

Concerning the relative value of neutral and acid arsenates no reliable experiments have demonstrated the superiority of either. It is commonly believed that the acid arsenates are more likely to burn foliage and we have received reports of injury from the use of Swift's which would seem to support the inference. Manufacturers advise using 3 pounds arsenate of lead to 50 gallons of water. We usually recommend 2 pounds, and Melander, of Washington, recommends to drench the trees with a weak solution of 1 pound to 50 gallons. Recently there has been placed upon the market a product known as zinc arsenite, which is said to be cheaper and better than arsenate of lead. Several growers have reported injury from this spray and it does not appear favorable. We have experimented with this spray during the past season and found it quite satisfactory.

Cottony Maple Scale

Pulvinaria vitis Linn.
Pulvinaria innumerabilis Rathv.

General Appearance

This species can be easily recognized in early summer by the large white cottony egg-sacs which are posterior to the brown female bodies.

Life History

The eggs are very small, oval, and white to yellow in color. They are deposited in the large, loose, cottony sacs, which are secreted by the females. The young first settle on the leaves and later move to the limbs. The males appear late in the fall to mate and die. In the spring the females increase very rapidly and after egg-laying shrivel and die. There is but one generation a year.

Distribution

Maine to California.

Food Plants

Maple, pear, apple, plum, peach, grape, sumach, linden, sycamore, locust, beech, elm, oak, orange, box-elder, spindle-tree, mulberry, alder, hawthorn, lilac, blackberry, willow.

Control

Kerosene and carbolic acid emulsions, or resin wash, applied when the young are hatching will aid in reducing the coming broods.

Natural Enemies

There are many natural enemies, including *Rhizobius ventralis*, *Coccophagus lecanii* and *Encyrtus flavus*, which prey upon this coccid.

E. O. Essig

Curculio

Anthonomus quadrigibbus Say
Conotrachelus nenuphar Herbst.

Two species attack the apple. The plum curculio and the apple curculio. *Conotrachelus nenuphar*, Herbst. and *Anthonomus quadrigibbus*, Say. Doubtless the curculio does more injury to the apple crop in some of the Central states than any other insect except the codling moth. It is a snout beetle about one-fourth inch long and of a dark grayish color. The snout is long and slender and may be folded under the body. The beetle winters under rubbish or in the soil and in early spring begins feeding on the opening leaves. After fruit sets it may gnaw little holes in the fruit, but it does most damage by laying its eggs in the fruit, cutting a crescent flap at the place where the egg is laid.

This insect infests the plum, cherry, and peach, as well as the apple. Comparatively few of its larvae develop in the apple but they develop freely in the plum and sweet cherry. They develop less readily in the sour cherry and peach. Since damage to peach, cherry and plum often results from the fruit rot fungus entering through the wounds made by the curculio. Orchards well cared for and sprayed for codling moth and other pests will not be unduly troubled.

S. A. Beach,
Ames, Ia.

Reference.—Illinois Experiment Station Bulletin No. 98.

Curtis Scale. See *European Fruit Scale,* this section.

Ermine Moth
Yponomentidae

Small moths with snowy white, black dotted front wings. The hind wings are gray or leaden in color.

Imported to New York from Europe upon nursery stock.

As the larvae feed upon the foliage they are easily controlled by arsenical sprays.

They attack apple and cherry as well as a variety of other plants.

Geneva Technical Bulletin No. 24.

European Fruit Lecanium. See *Prune.*

European Fruit Scale or Curtis Scale
Aspidiotus Ostreaeformis

The female is circular or broadly oval in outline, dark ashy gray in color with paler margin; sometimes the scale is nearly white. The exuvia is central or nearly so, dark brown, usually naked and glossy. Diameter ⅛ of an inch.

Life History

The winter is passed by partly grown individuals which become mature early in the summer. The insect gives birth to living young which begin to appear soon after the maturity of the female. In this State they are apparently but one brooded.

This scale has been recorded from a number of different plants, among them, the apple, pear, plum, peach, cherry, birch, poplar, horse chestnut, basswood, alder, haw, maple, aspen, oak, etc. It has been reported in this country from Maine, New York, New Jersey, Michigan, Ohio, Iowa, Idaho, California and several other states. In Maine it is most frequently found on large trees in old and neglected orchards, though we have records also of its occurrence on currant bushes. Specimens the past season were received from Brunswick, Millvale, Buckfield and W. Auburn.

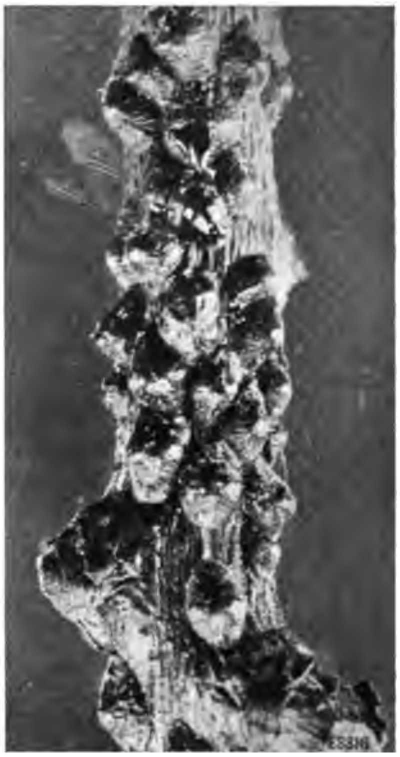

Fig. 1. The European Fruit Scale on Branch of Apricot. (Essig. Bulletin 2, Vent. Co. Hort. Com., Cal.)

Remedies

Spraying with lime-sulphur late in the winter or early spring before the appearance of the leaves will control it.

O. A. Johansen,
Orono, Me.

Eye Spotted Bud Moth
Tmetocera ocellana Schlieff

H. F. Wilson

The larvae of this moth resemble those of the Peach and Prune Twig Miner quite closely, and they are often mistaken one for the other, but the latter work only on the stone fruits, while the former work on practically all of the orchard trees. By careful examination they can readily be distinguished by the anal shield, which on the above insect is shining black like the head and thoracic shield, while that of the twig miner is the same as the rest of the body. When fully grown, the larvae are one-half inch long and of a dirty gray color. They are not yet full grown with the opening of the buds in spring and will feed upon the blossoms during the entire blossoming period. They may mat the blossoms and leaves of a cluster together with their silken threads within which they feed, making it difficult to reach them with spray.

Life History

The larvae, like those of the twig miner, winter on the twigs and branches in an immature condition, but while the twig miner excavates a cavity in the bark, the larvae of the bud moth form minute inconspicuous cocoons on the bark. This is a peculiar habit of a few larvae that form cocoons before reaching maturity.

As the buds start in spring the larvae leave their winter quarters and begin feeding upon the outcoming leaves and blossoms. They mature in early May, pupate, and in from 10 to 14 days appear as adults. The moths deposit eggs in late May and early June, probably upon the leaves (although this has not been determined). The young larvae feed on the under surface of the leaves and skeletonize them, especially in the vicinity of the midrib. So far as known, there is but one generation, although from the shortness of the life cycle, it is apparent that moths from the first brood might produce a second generation that would mature in time to deposit eggs for the spring forms.

Remedies

There are three methods of control. The first is to spray the trees before the buds start in spring in order to destroy the overwintering larvae. One application of crude oil emulsion or kerosene emulsion, applied just before the buds start, would be the most effective means for this.

The second method is to spray with arsenicals when the larvae are feeding upon the foliage and blossoms, but they are sometimes hard to reach, especially when they have matted the blossoms together. The pome fruits that are well sprayed for the codling moth will not be bothered with the bud moth.

Third. Recent experiments tend to show that the best time to spray for this insect is in the fall at a time when the larvae are working on the under side of the leaves. This spray applied about September 1, will also help to catch a great many codling moth larvae.

Fall Web Worm

Hyphantria cunea Dru

The moth producing this caterpillar is white and sometimes has a few black spots on the wings. The larvae hatching from masses of eggs laid on different parts of the trees spin their webs which extend over quite an area. These webs may be noticed in the Mesilla valley by the middle of July on a number of trees, but more particularly on the cottonwood and poplar. The caterpillars will first eat all the leaves within the web, then those nearest by, often defoliating the entire tree. The worm is noticeably set with

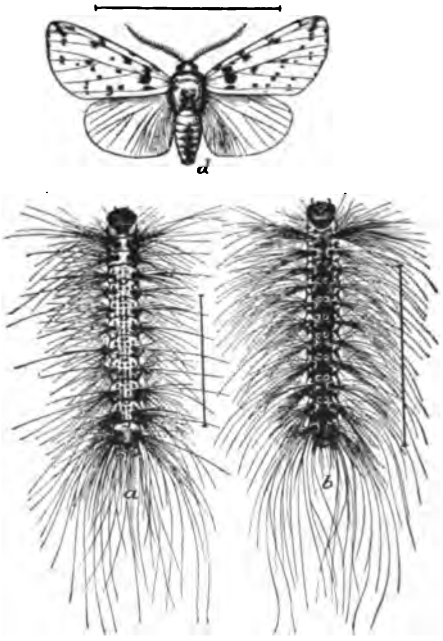

Fig. 1. Fall Web Worm. *a*, *b*, caterpillars; *d*, moth. (Howard, yearbook, 1895, B. of Ent. U. S. D. A.)

tufts of bristle-like projections. Two broods are reported, the last one seems to be the worst. This insect is sometimes confused with the tent caterpillar which appears in the spring and builds its webs in the forks of the limbs.

Remedies

The clusters of eggs on the limbs should be destroyed if possible when the leaves are off. The webs or tents may be cut out and destroyed or they may be burned with a torch. If this cannot be done spray with standard solutions of some of the arsenical mixtures.

FABIAN GARCIA

Fruit Tree Bark Beetle

Scolytus rugulosus Ratz

General Characteristics and Method of Work

Orchard trees are subject to the attack of a small boring insect, the fruit tree bark beetle *(Scolytus rugulosus* Ratz), its presence being manifested by what are called "worm holes," minute round openings in the outer bark scarcely a sixteenth of an inch in diameter, accompanied by wilting of the leaves and shriveling of the bark, and, in the case of stone-fruit trees, by more or less copious exudations of gum. The first appearing holes are made by the parent beetles in entering the bark to deposit their eggs, but later, if no effort is made to check the insect's work, the bark will be found thickly "peppered" with holes as though by fine bird shot. These are the exit holes of beetles that have in their larval stage mined and developed under the bark.

Distribution

Since first observed in this country in 1877 the species has spread pretty generally from New York westward to the Mississippi states.

Life History

As early as the middle of March, first of April or later in May, according to locality and season, the parent beetles make their first appearance and may be seen crawling about orchard trees and beginning to burrow through the bark. After penetrating to the sapwood, the female constructs, partly within the bark and partly in the wood next to it, a vertical gallery or brood chamber, and along the sides of this at very short intervals gnaws little pockets in which she deposits her eggs. The minute, whitish, grub-like larvae hatching from these eggs excavate little side galleries, which start out at right angles to the brood chamber but soon diverge and widen with the increase in size of the growing larvae. Much more frequently this insect lives in such numbers, with its galleries so closely packed together under the bark of a tree, that it is with difficulty that individual galleries can be distinguished.

The complete transformation from egg to adult occupies from four to six weeks. There are two, and possibly three, broods.

Remedies

The beetles are held in check by a number of parasites. The "cutting out" method in use against other borers is of little avail in this case.

Where clean culture is practised and trees are regularly sprayed for codling moth and scale these insects will be in large measure repelled. The beetles may be killed in specially infested areas by light applications of kerosene oil, after which these areas should be cut away.

From Div. Ento. Circular 29, Revised.

Fruit Tree Leaf Roller

Archips argyrospila Walk

Introduction

Until quite recently the fruit tree leaf roller *(Archips argyrospila* Walk) has been looked upon as an insect of only minor importance to cultivated crops. During the past few years, however, it has become unusually abundant and has caused considerable loss to fruit growers in certain sections, notably in Colorado and New Mexico and in New York state.

The damage incurred by the leaf roller has varied from 25 to 90 per cent of the entire fruit crop, depending on the measures of control adopted, the abundance of the "worms," and the kind or variety of fruit attacked. In unsprayed orchards the writer has seen the entire fruit crop ruined by the larvae, and the trees completely defoliated so that not a green leaf could be noticed. When trees are so defoliated it is hardly possible for them to produce fruit buds for the following season.

Distribution

The fruit tree leaf roller is generally distributed throughout the United States. Stedman, in Bulletin No. 71 of the Missouri Experiment Station, page 7, states that "this insect is found in damaging numbers practically all over the United States from Maine to the Gulf and westward to the Pacific coast and up as far as Oregon."

Food Plants

The insect is a very general feeder and consequently has been reported on a large number of plants. It appears at times in injurious numbers on apple, pear, plum, cherry, apricot, quince, peach, rose, currant, raspberry and gooseberry.

Character of Injury

As the manner in which the larvae attack the various host plants differs to a certain degree, it seems advisable to give a rather full discussion of the more important injuries, especially those occurring on fruit trees.

In the spring, just as the buds are bursting, the larvae begin to gnaw their way out of the eggshells and hard protective covering of the egg masses. The young caterpillars at once migrate to the developing buds and begin feeding on the unfolding leaves. At first they eat small inconspicuous holes in the unfolded leaves, and at this time the average orchardist is not aware of their presence. After feeding in this manner for a few days the larvae become quite conspicuous as they begin to spin fine silken threads from leaf to leaf. Eventually they fold or roll up a single leaf or a cluster of leaves and here they feed for the greater part of the time, though occasionally straying out of their concealment to feed in the open. Before the blossoms are fully out, or even before the cluster buds have separated, the "worms" can be observed webbing them together and feeding voraciously. Very often serious injury results before the trees come into blossom. Later in the season the webs produced by the larvae are often quite conspicuous.

As soon as the young fruit has set the larvae cease feeding on the foliage to a large extent, and now fasten one or more leaves to the fruit and within this protection feed greedily, at first eating the skin only, but shortly consuming the pulp and the seeds or stone, depending on the kind of fruit attacked. Sometimes young apples are completely devoured except for the stem and a portion of the calyx end. Cases have been noticed where the larvae have completely gnawed through the stems, thus causing the fruit to fall to the ground or remain suspended within the feeding nest. Damage done to apples as well as other fruits is usually so severe that the fruit can not outgrow the injury, thus causing a large percentage of unmerchantable or second-class fruit at picking time. Much fruit is also caused to fall prematurely on account of the serious injury inflicted on it when young.

Life Habits

The Egg

The female moth deposits her eggs in compact oval clusters of about twenty-five to more than one hundred, anywhere upon the bark of the fruit trees that serve as its food supply. As soon as the egg mass has been deposited, the female moth smears the eggs over with an impervious material which is thrown out from the extremity of the abdomen, and which protects the eggs from the inclemencies of the weather and the attacks of predaceous insects for nearly ten months, or until the buds begin to open the following year. So there is but one brood of the worms each summer.

The eggs are stuck so tightly to the bark when they are deposited that they often remain for several years. The old egg patches are readily recognized by the numerous small punctures from which the larvae or worms escaped.

The Larvae or Worms

The larvae do not all hatch at once, those in the warmer situations being the first to emerge, and those coming from a single egg patch usually vary several days in their date of emergence.

The date of hatching is by no means constant, but is determined by the earliness or lateness of the season, exactly as is the time for the opening of the buds. The earliest of the larvae emerge with the first bursting of the buds of the apple trees, and when the blossom buds of the apple begin to show their pink color the larvae of the leaf roller have mostly hatched. The active hatching season is usually distributed over about one week to ten days, the time varying with the temperature. If the days and nights are cool, the period lasts longer than if hatching takes place at a time when the days and nights are warm.

At first the larvae are very small, hardly one-sixteenth of an inch in length, and dull greenish-yellow in color, with black heads. As they feed and grow, they become deeper green in color, and the black head and first segment of the body above become quite conspicuous.

On hatching, the little larva goes at once in search of food, and may eat into an unopened bud or find its way into one of the folds of the tender unfolding leaves, which it soon ties together with delicate silken threads of its own manufacture. Thirty days of feeding are sufficient to mature the larva, which then ceases to feed, and in a few days more changes to the third, or chrysalis (pupal), stage, usually among the curled leaves which it has tied together with the silk threads above mentioned.

The Moth

The moths measure from three-eighths to four-eighths of an inch in length with the wings closed; the expanse of the full-spread wings usually varies between eleven-sixteenths and one inch, the prevailing color is a rusty brown, varying in typical specimens from rather light to quite dark, and there is always present a large pale-yellow to almost white diagonal patch on the front margin of the wing a little beyond the middle.

Natural Enemies

The fruit tree leaf roller has numerous bird and insect foes which tend to hold it in check. The various bird enemies are the blue bird, robin, catbird, red-winged blackbird, oriole, kingbird, phoebe and English sparrow.

The fruit tree leaf roller in the larval stage has been found difficult of control because of the manner in which the larvae feed on the foliage and fruit, and also on account of the fact that they are very resistant to poison sprays. Applications of arsenicals alone and in combination with 40 per cent nicotine solution have greatly reduced the amount of injury to the fruit and foliage, but these sprays have not been so effective as is desirable.

A series of experiments for the destruction of the egg masses, conducted during the dormant season, have shown the value of mineral oils. Kerosene emulsion, crude-petroleum emulsion, and miscible oils have been tested. The last mentioned, when used at the strength commonly employed against the San Jose scale—that is, 1 gallon to 15 gallons of water—will prevent most of the eggs from hatching. From 93.23 to 96.21 per cent of the egg masses were destroyed by this material on the experimental plats. Good results also were obtained by the use of kerosene and crude-petroleum emulsions, although these substances were, on the whole, not quite equal to the miscible oils. The ease with which sprays may be prepared from these last commend them to many orchardists although the home made emulsions are cheaper. In preparing a kerosene or crude-petroleum emulsion care is necessary to insure a thorough and stable emulsion.

It should be stated that injury to trees treated with oils sometimes follows, although no such injury was noted in connection with the present experiments. No more spray should be used than is necessary properly to treat the tree, and the puddling of oil around the crown should be guarded against.

Lime-sulphur solutions proved to be a decided failure as a destroyer of the egg masses. Strengths ranging from 1 gallon of lime-sulphur to 7 gallons of water to 1 gallon of lime-sulphur to 10 gallons of water were sprayed on apple trees and no benefit was derived from their use.

Recommendations for Control

Experimental work has shown that the best method for controlling the fruit tree leaf roller is by a very thorough application of a miscible oil at the rate of 1 gallon to 15 gallons of water during the dormant season. It must be understood that by thoroughness of application is meant the use of enough material to cover all parts of the tree, from the tip of the highest or smallest branch to the very base of the trunk. In order to do thorough work the trees must necessarily be sprayed from all directions. It is very often the case that the top branches or those around the inside are missed by the man operating the rod. It must be remembered that only those egg masses actually hit or covered with the material will fail to hatch and those missed will surely hatch out "worms" in the spring to feed upon the trees. Orchardists should realize that thorough spraying with the right material and at the proper time pays well, but careless, haphazard work gives disappointing returns.

All plants upon which eggs have been laid should be sprayed. Besides fruit trees, egg masses may be found on various shade trees, shrubs, and currant, gooseberry, raspberry, and rose bushes, etc. Eggs will also be found on buildings, spray outfits, wagons, fences, etc., and it is recommended that these egg masses be crushed so far as is practicable.

The best time to spray is just before the buds burst in the spring. Late spring is preferable to early spring, as weather conditions are usually more favorable. There is also less likelihood of injury to the trees by the oil after the sap has begun to flow with considerable pressure. Spraying should not be done during threatening weather. Orchardists should bear in mind that the strength of miscible oil recommended is for a dormant spray and should never be applied to trees in foliage. Spraying should be completed in the spring before the buds have advanced so far as to have the green tips exposed. If the above precautions are carefully followed in applying the miscible oil, danger of injury to trees will be reduced to the minimum.

There are a number of good commercial brands of miscible oil on the market. These miscible or soluble oils are so made that they mix readily with water. Nozzles with medium-sized holes or apertures are recommended.

Miscible oils at the strength recommended for the destruction of the eggs of the fruit tree leaf roller are valuable in controlling scale insects such as the San Jose scale, Howard scale, etc. Orchards sprayed with the oil for the leaf rollers will not require the usual application of lime-sulphur for the San Jose or Howard scales.

In conjunction with the oil treatment in badly infested districts it is recommended that a very thorough application of arsenate of lead, at the rate of 3 pounds to 50 gallons of water, be applied when the larvae are emerging from the eggs. The larvae will be found to be hatching just as the cluster buds on early-blooming varieties of apple are beginning to separate. The necessity for making this application will depend largely upon the thoroughness with which the miscible oil was applied.

From Div. Ents. Circular 29, Reissued.

References

Bureau Entomology, Bulletin 116.

Colorado Board of Horticulture, 1912 Report.

Cornell Bulletin 311.

Fruit Tree Leaf Syneta

Syneta albida Lec.

H. F. Wilson

Although this insect has been doing quite a little damage for some time, there

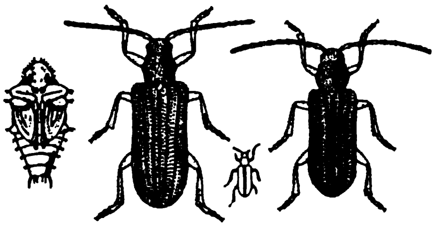

Fig. 1. The Fruit Tree Leaf Syneta: Pupa and adult. (Original)

are practically no published notes on its habits and life history.

The adults suddenly begin to appear in the spring at the time when the apple blossoms are opening and are very abundant for a few weeks, when they suddenly begin to disappear and in a few days can only be found in scattering numbers.

We have been unable to locate the eggs but suppose they are deposited in the ground upon roots of some kind. During 1912 larvae dug from the ground beneath apple trees formed into pupae and later changed to the adult stage. At that time it was impossible to tell whether the larvae were feeding upon the roots of apple or upon the roots of some grass or weed as the roots of all three were more or less intermingled. A number of larvae were found at a depth of fourteen inches below the surface of the ground.

The only injury which we are acquainted with is that done by the adults and at times this is quite serious. When the blossoms are opening in the spring, the adults can be found feeding on the petals and one would suppose that the fruit would suffer as a result, but apparently the principal parts of the flower are left uninjured. Later in the season the leaves of apples and prunes are the principal parts eaten, and oftentimes trees will have nearly every leaf with from one to several holes eaten out. The worst and most serious injury is done to young grafts, especially where whole orchards are being grafted over. These grafts where the leaves are continually eaten away for several years are killed, and consequently the tree itself is lost.

Remedies

Such remedies as have been tried are more or less unsatisfactory. Arsenate of lead in ordinary strengths fails to destroy the beetles, and stronger strengths seem to be only partially successful. With young grafts the beetles can be kept away by the use of cheesecloth sacks placed over the grafts.

Greedy Scale

Aspidiotus camelliae Sign

Aspidiotus rapax Comst.

General Appearance

This scale greatly resembles the San Jose scale, but is somewhat lighter in color, larger, much more convex, being noticeably high and with exuviæ near one side. The shell is thin, showing the yellow body beneath.

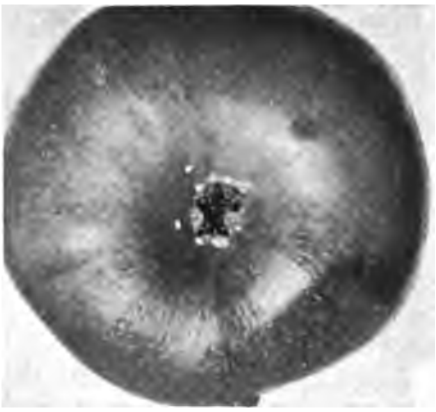

Fig. 1. Greedy Scale (*Aspidiotus camelliae* Sign.) around calyx of apple. (Cal. Hort. Com.)

Distribution

One of the commonest scale insects and found in wild as well as cultivated areas throughout the state.

Food Plants

This species attacks a very large list of plants, though it has never yet become a serious pest to any horticultural or agricultural product. Among the food plants reported in California are quince, eucalyptus, fuchsia, English ivy, mountain holly, walnut, myrtle, olive, cottonwood, almond, cherry, pomegranate, pear, apple, rose, willow, California bay or pepperwood and grape.

Natural Enemies

An undetermined internal parasite has been bred from this species.

E. O. Essig

Green Apple Aphis

Aphis pomi or *Aphis mali*

These lice lay their shiny black eggs in October and November in crevices of the bark and in scales of the buds of the apple trees. After the first brood hatches in the spring about the time of the unfolding of the first buds and until late in the autumn they may be found at all times on the apple trees. Their presence in the spring may be detected by the curling of the tender leaves on the under side of which the aphids make their home.

These lice, like others of the family, eat more than they can assimilate and the excess exudes from the "honey tubes" near the posterior end or from the anal opening. "This liquid is highly prized by the ants, which are nearly always to be found running over and around the aphis colonies. It is a great mistake to suppose that ants eat the aphis or injure them in any way; on the other hand ants often protect and aid some species of lice in return for the sweet liquid, called honey dew, of which they are so fond.

*"The honey dew is directly responsible for the black, sooty fungus growth which nearly always follows the appearance of the green leaf aphis. The fungus thrives on this honey dew, and soon clogs the breathing pores of the leaves, resulting in their turning brown, withering and dying. In this manner it may prove quite injurious to leaves not actually infested by aphids because such quantities of honey dew drops from aphis colonies to the leaves beneath."

The first two or three generations of

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* R. I. Smith, North Carolina Experiment Station, Bulletin 206.

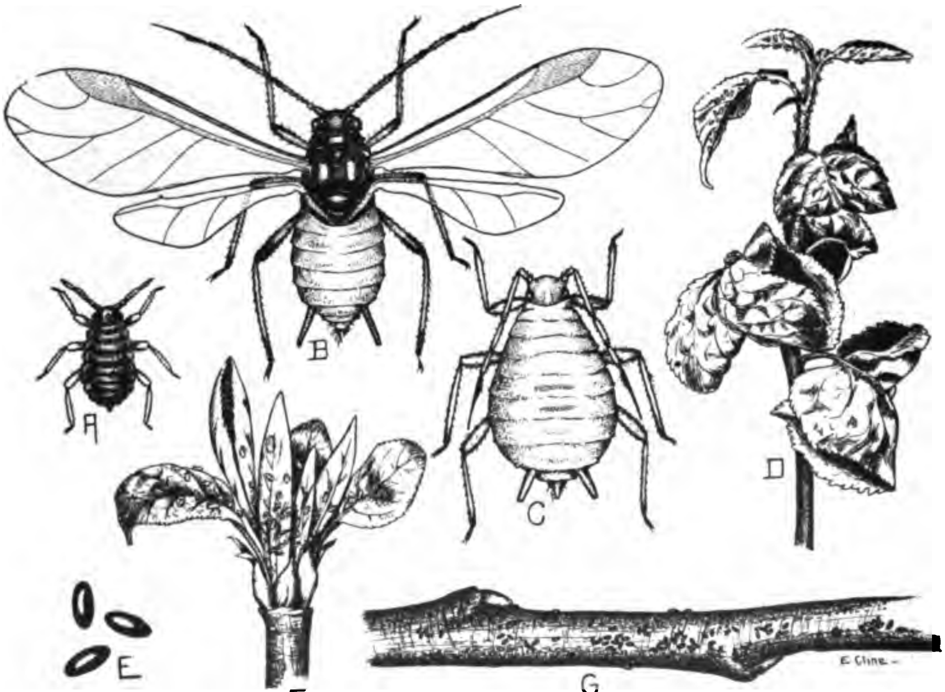


Fig. 2. Apple Aphis. A, stem mother just hatched from egg; B, winged female such as migrate from tree to tree during summer; C, wingless female of summer form; D, leaves curled by this aphis; E, eggs magnified; F, buds just opening, showing newly hatched eggs; G, twig showing eggs as they appear in the winter time. (Montana Experiment Station)

this aphid give birth to both winged and wingless forms. After the third brood no winged generations appear. All broods after the first are viviparous females, that is, they give birth to living young. Each "stem mother" gives birth to about fifty at the rate of eight to ten per day, each new generation coming to maturity in about ten days or less. All this time no males have been present in the colony but some appear in the last brood in the fall and with this generation eggs are produced which preserve the species over winter.

Control

For remedies see end of general article on aphids.—Ed.

Green Fruit Worm or Green Apple Worm
Xylena sp.

The green fruit worm is a yellowish green, naked caterpillar, which eats into the sides of the small green apple, the results of which are shown in the cut. It also eats the leaves. When fully grown it is nearly an inch and a half long. Numerous reports from the Bitter Root valley indicate that considerable damage is done by them there. The caterpillars often make only small openings in the skin of the young apples, but instead of healing smoothly these wounds form a rusty or corky area, which has often been mistaken for the true apple scab by persons who have not seen the latter. Similar injury is sometimes done to the pear.

Other Food Plants

Besides the apple and the pear a considerable number of other plants are fed upon by this insect, including peach, plum, quince, currant, oak, wild cherry, box elder and rose. It is probable that other plants, at present unknown, are included in the diet of these caterpillars. With this list of food plants, it is apparent that we cannot hope to ever approach eradication and that our efforts should be directed merely toward reducing the damage in the orchards.

Distribution

The exact identity of the parent of these fruit worms is not known, but it is probable that the species concerned is of wide distribution in the United States.

Life History

This species belongs to the same family of moths as the ordinary cut worms and the parent insect is a dull, night-flying moth, which would not attract attention if it were to be seen by the fruit grower. The details of its life history are not well known. It is probable the eggs are laid soon after the leaf buds open and the young worms hatching a few days later feed first on the leaves and later on the fruits. They continue their feeding through the early part of the season and reach full size about the time the apples are an inch in diameter, when they go into the soil and pupate. In the late summer and early fall the moths issue from the pupae and pass the winter under any favorable shelter. In the spring they resume activity and deposit their eggs on the trees as above indicated.

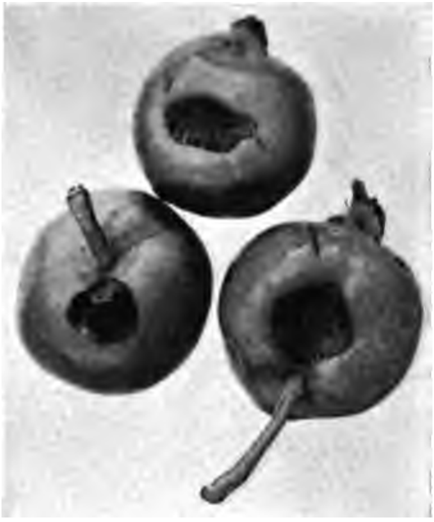


Fig. 1. After Effects of Green Fruit Worm. (Original)

Control

Clearly, spraying is the only method by which we may expect to be able to destroy these worms and, from the fact that they feed extensively upon the foliage, it would appear to be easy to get satisfactory results.

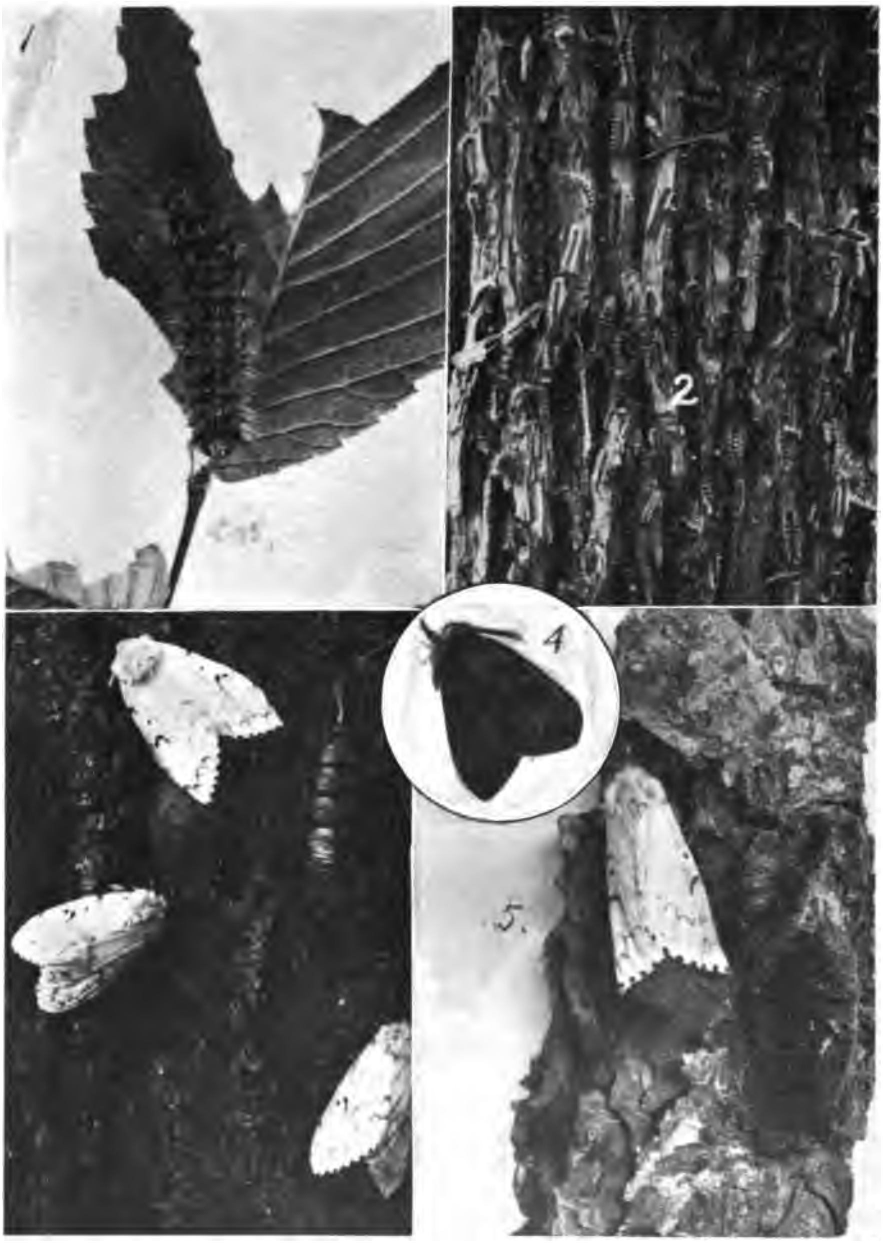


Fig. 1. Gypsy Moth. 1, caterpillar feeding; 2, caterpillars climbing a tree; 3, female moths and pupa; 4, male moth; 5, female laying eggs. (Mass. Dept. Agri.)

Professor Slingerland, of Cornell University, has pointed out that in the experience of some of his correspondents, it is very difficult to kill this green fruit worm after the apples are large enough to furnish food. It is probable that an early spraying would be effective and we recommend that four pounds of arsenate lead be added to every 50 gallons of lime-sulphur or the tobacco extract applied just before the fruit buds open, or in water at the same time or a little earlier if there is no other pest requiring treatment.

R. A. Cooley,
Montana Circular No. 17.

Gypsy Moth

Porthetria dispar Linn.

By H. F. Wilson

Like many other of our most serious pests this insect was imported from Europe and has been the cause of considerable trouble in this country. We do not as yet have this pest in the Northwest, but everyone is warned to be on the lookout for it.

The eggs are deposited in masses measuring three-fourths by one-half inches and containing approximately 500 eggs. At first these egg masses are yellowish in appearance but during the winter, exposure to the weather causes them to become a dingy white. The individual eggs are about the size of a pinhead, and when first deposited are salmon colored, turning dark in the course of a few weeks.

These eggs hatch in the spring and each egg mass produces a mass of young dark caterpillars, which become full grown by midsummer. The caterpillars are decidedly hairy and as they grow older assume a varied coloring along the back. Starting from the head, which appears mostly yellow, may be found a double row of five pairs of blue spots; these become very distinct on the larvae as they reach maturity and as the larvae are entirely distinct from any others which we have in the Northwest, they should be easily recognized if one meets with them.

When full grown, which is in midsummer, the caterpillar spins a few strands of silk for support and changes to a chrysalis, which is the pupal stage. In this stage they are dark reddish in color and thinly sprinkled with light reddish hairs. They remain in this stage for about two weeks and then change to the adult insect. The female moth is white with numerous black markings, is quite robust and moves about very sluggishly.

The male is brownish yellow with sometimes a greenish tinge. They fly about during the day and after mating with the females live but a very short time. The males measure about one and one-half inches from tip to tip of wing. The females measure about two inches but do not fly and therefore do not spread as rapidly as they might. After copulation takes place the females deposit their eggs and die.

This pest is probably mostly distributed by egg masses on nursery stock, but as the larvae have a habit of spinning webs and dropping from trees they are oftentimes carried on automobiles and other vehicles for long distances.

The gypsy moth caterpillar will attack all fruit, shade and woodland trees. Apple trees seem to be preferred above all others.

There are many natural enemies of the gypsy moth and in Europe these are sufficient to keep it under control.

In the United States it will be necessary to wage combat until such natural enemies as are being imported can increase to numbers corresponding to those of the gypsy moth.

Remedies

The most effective time to catch this insect is in the egg mass. These wherever accessible, can be killed by soaking them in creosote. When the caterpillars are quite small they can be poisoned with arsenate of lead at the rate of 10 pounds to 100 gallons of water. This can be applied with any of the common force pumps.

Natural Enemies

(The numerous parasites which the entomologists of the Department of Agriculture have imported, it is stated, are beginning to control this pest.—Ed.)

Hag Moth

Phobetron pithecium

This is a slug-like caterpillar of very singular form, sometimes found upon apple, oak and wild cherry. It reaches a length of 0.60 inch. Extending out from each side of its body are four long tentacle-like curved and tapering fleshy processes. The color is dark brown. The adult is a purplish brown moth, with a stretch of front wings of a trifle less than one inch.

The insect pupates in a papery cocoon upon the outside of which are attached the long processes from the body of the caterpillar. These bear nettle-hairs which have been thought to protect the enclosed pupa from enemies. The cocoons are attached to twigs and bark.

The insect is interesting chiefly because of its singular appearance. It is never common.

Hickory Tiger Moth

Halesidota caryae

So called because of the color and spotting of the wings. The caterpillars are about one and one-half inches long and have a row of eight black tufts along the back, and two long black pencils, each on the fourth and tenth segments. Orchards sprayed for codling moth will not be troubled.

Ivy or Oleander Scale

Aspidiotus hederae, Vall.

General Appearance.—Circular flat scale, one-sixteenth to one-eighth of an inch in diameter, the male scales being very much smaller. The color varies from light to dark gray.

The life history is the same as the San Jose scale. It is distributed generally throughout the country.

Control.—Same as San Jose scale. A small chalcid fly works effectively on this scale.

E. O. Essig,
Cal. Hort. Com.

Leaf Crumpler.—See *Apple Leaf Crumpler*, this section.

Leaf Hopper.—See *Apple Leaf Hopper*, this section.

Leaf Miner.—See *Trumpet Leaf Miner*, this section.

Leaf Roller.—See *Oblique Banded Leaf Roller*, this section.

Leaf Sewer.—See *Apple Leaf Sewer*, this section.

Leaf Syneta.—See *Fruit Tree Leaf Syneta*, this section.

Lecanium.—See *European Fruit Lecanium*, this section.

Lesser Apple Leaf Folder

Acleris minuta Rob.

This leaf folder commences work with the opening of the leaves. The eggs for the spring brood are laid by a small slate-gray moth and hatch into small green worms, having pale brown or yellowish heads with white markings. The opposite edges of the young leaves are drawn together upwards and fastened with a silken web, thus forming a roofed chamber within which the caterpillar lives. Like all of its family, when alarmed, it deftly lowers itself to the ground by means of a silken thread. It is controlled by the lime-sulphur wash.

H. A. Gossard

Lesser Apple Worm

Enarmonia prunivora Walsh

During the past few years the species known as *Enarmonia prunivora* has been found very commonly infesting the fruit of the apple in various parts of the United States, in some sections so abundantly as to cause serious loss to orchardists, the insect ranking in importance as an apple pest close to the codling moth.

The small, fusiform, flesh-colored larvae, about three-eighths of an inch long, injure the fruit around the calyx by eating out shallow cavities or boring holes into the flesh from one-fourth to one-half inch or more in depth, in the ripening fruit occasionally penetrating to the seeds. The surface of the fruit, especially in the calyx basin, is also injured, the larvae working beneath the skin and eating out galleries or large blotch mines, frequently with holes or borings extending more deeply into the flesh. The work of this species resembles rather closely that of the codling moth, and the similarity of the larva to the codling moth larva and the further similarity in the life history and habits of the two species have doubtless been responsible for the almost complete oversight in the United States of this species as an important enemy of the apple.

Control

The common measures used against the codling moth have served to keep this species in check.

Lime Tree Winter Moth

Erannis tiliaria

The females are wingless and late in October or early in November may be seen ascending the trunks of trees. They are spider-like creatures with yellowish white bodies.

Band with tree tanglefoot to prevent their ascent.

Mediterranean Fruit Fly

Ceratitis capitata Wiedemann

H. F. Wilson

In countries where this pest has gained a foothold it is one of the greatest insect enemies of fruit raising. At the present time it is believed that Brazil is its native home. Adults have been reared from apricots, peach, pear, plum, apple, fig, oranges, lemons and a number of other important fruits.

Means of Distribution

From evidence gathered in various sources the pest is distributed in fruit. An extract from bulletin 28 of the Department of Agriculture, Cape of Good Hope (South Africa), will show the danger to fruit growing in the United States should it gain a foothold. "It is no doubt carried into distant localities in infested fruit. Visit almost any morning market in the Colony after apricots and peaches are ripe and you can find maggots and puparia in abundance. That this fruit is purchased and shipped to other places, or carried away in small lots goes without saying. While visiting one of our most important markets on a Saturday morning during February, 1904, I found loads of infested peaches. There was absolutely no sale for the most of them, and the growers in disgust dumped them out on the ground. I said nothing, for, in the first place, I had absolutely no right or authority in the matter, and secondly, I wished to note the course of events. They were being removed by 7 o'clock Monday morning, but the ground for yards around was dotted white with maggots trying to hide away for transformation, and puparia could be picked up by the hundred. Under such a deplorable state of affairs it is quite possible that some of the adults would again find their way into wagons and be carried away to distant farms."

The adult fly is yellowish with black and white markings. Both wings being banded with yellow and with a series of black lines toward the base. The abdomen is yellow and is crossed with two white bands.

The larvae or maggots resemble those of any of our common flies, such as the cabbage root maggot.

The life history in general is about as follows: The eggs are deposited in the fruit by means of the sharp ovipositor with which each female is furnished. As soon as they hatch, the young larvae at once begin to feed on the pulp of the fruit. When fully developed, which usually requires about three weeks, they leave the fruit and enter the ground where they change to puparia and later to adults. The adults push up through the soil and in a short time are ready for work. A very efficient remedy has been found for this insect in South Africa which prevents the adults from depositing their eggs.

Mites.—See *Red Spider*, this section, and *Blister Mite*, under *Pear*.

Oblique-Banded Leaf Roller

Cacoecia rosana Harris

H. F. Wilson

Appearing on various plants throughout the United States we may expect to find the larvae of this insect working on the leaves of all our cultivated pome, bush and small fruits. In extreme cases some little damage may be done to apples and pears. In these cases the skin of the fruit is eaten and even holes are made in the fruit which makes it unfit for sale.

The adults have a wing expanse of about one inch. General color leather colored brown with one opaque dusky band, beginning at the middle of the anterior margin and extending to the inner angle of the wing.

The larvae are pale green to reddish brown in color, with a dark brown head and a few sparse hairs rising from the head and body. The larvae of this insect should not be mistaken for that of the bud moth, which is a very abundant insect in Oregon found working in the buds. The larvae of this insect works on the leaves.

Remedies

Should this insect become abundant at any time it may easily be controlled by an application of spray as used for the codling moth.

Oleander Scale.—See *Ivy Scale*, this section.

Oyster Shell Scale

Lepidosaphes ulmi Linn.

H. F. Wilson

Probably as widely distributed as the San Jose scale, this insect is the cause of much injury to fruit trees throughout the United States.

It is not supposed to be as serious a pest as the San Jose scale, but is of considerable economic importance. Entire trees are seldom killed, but oftentimes single branches will become so weakened from their attack that they will not produce fruit and may die, and at times small trees become so stunted as to never grow into well balanced trees. Besides our fruit trees this insect infests a large number of shade trees, vines and bush fruits. The adult scales measure about one-eighth inch in length and are dark brown in color. In early spring these may appear grayish brown, due to bleaching by the winter rains. When present in large numbers the scales will overlap and assume various curved shapes. Apparently with the beginning of fall the entire abdomen of the female develops into eggs and the insect itself shrivels up and dies. If during the winter one of these scales be turned over, 50 to 100 small white oval eggs will be exposed to view.

These eggs hatch about the time the blossoms of the apples are falling, and the young crawl from under the scales and settle on the bark. The female molts twice in her growth according to Quaintance and Marlatt, and in the adult condition is entirely without legs or eyes, and is but a jelly-like mass, capable only of extracting sap from the tree and changing it into eggs.

The adult male undergoes similar changes under its scale but later assumes legs, wings and antennae, and emerging from under the scale flies about fertilizing females.

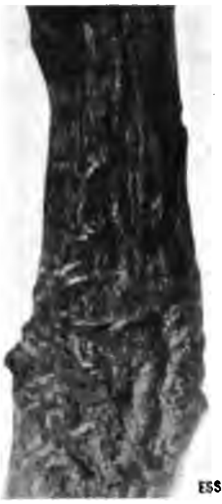


Fig. 1. The Oyster Shell Scale.

In its distribution from orchard to orchard, nursery stock probably plays the most important part, although other insects, birds, etc., may and do aid in the distribution from tree to tree.

Remedies

It has been stated that lime sulphur will not destroy the egg of this pest but we have observed that where this spray is consistently used for the San Jose scale that the oyster shell scale does not thrive and no extra application is needed. No doubt but that the eggs are very tenacious of life and hard to kill, but we believe that the insect can be held in check with the above spray.

Shade trees and low-growing plants, as currant, gooseberry, etc., often become so badly infested that it seems necessary to apply a spray. In such cases kerosene emulsion is used, and is applied just as the eggs are hatching in the spring. Considerable difficulty may be experienced here as the young are at that time considerably protected by the foliage. To secure the best possible results a high pressure pump should be used by means of which a pressure of 150 to 200 pounds can be secured. Apply spray to all parts in as thorough a manner as possible. (Use kerosene emulsion 8 to 10 per cent strength.) For preparation of kerosene emulsion see sprays for aphis.

PEAR BLIGHT BEETLE.—See *Shot Hole Borer*, under *Cherry*.

Periodical Cicada

Tibican septendecim Linn.

H. F. WILSON

There are probably very few of us who are not acquainted with this insect in the adult stage on account of the large numbers which appear at one time or another in various sections of the country. The name is applied on account of the fact that the adults only appear at periods of every 17 or 13 years. In the northern part of the United States it is 17, in the south 13. During the intervening time they live in the ground as nymphs and live by sucking the juices from the roots of trees. Having reached that point where they are ready to become adults, they crawl out of the ground and on to a stone, tree trunk or anything above ground, and shedding the skin for the last time, come forth as adults.

After leaving the old shell they are ready to fly about in a day or two, and within a week the sexes have mated and the females shortly proceed to make their egg punctures and deposit eggs here and there in the twigs.

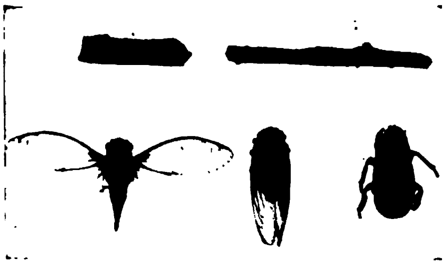


Fig. 1. Periodical Cicada: Egg punctures in twigs; pupal case and adult insect. (After Cordley.)

In selecting trees for egg oviposition oaks are shown a preference and among fruit trees apples seem to be preferred. Almost any plant may be attacked.

The part of the plant selected is almost invariably the twigs of the previous year's growth. Occasionally a single nest or two will be constructed in a larger limb.

The result of such work must of a necessity be quite detrimental to the trees as the twigs are often so weakened that they break very easily and an excessive pruning results. In the nursery considerable damage may be caused by the aftereffect, which is shown in the deformities of slow-healing wounds. These wounds offer excellent entrance ports for fungus diseases and other insects. The woolly apple aphis oftentimes locate in these scars and instead of healing over they become more deformed and susceptible to the attacks of fungus and insects.

In depositing her eggs the female cicada passes from one limb to another until she has deposited all of her eggs, which have been estimated to number from 400 to 600. The eggs measure about one-twelfth inch in length. They hatch in six or seven weeks, are pearly white in appearance, tapering to an obtuse point at either end and slightly curved. Upon hatching from the eggs the young larvae run about for a very short time, drop to the ground where they seek out a crevice and immediately work their way into the soil and begin their long underground existence.

Remedies

A number of insecticides are quite effective against this species, but to be of real value must be applied each day as long as the insects issue in numbers. Pyrethrum powder is a perfectly satisfactory remedy against newly transformed individuals. This should be applied in the morning, before the insects have gained full strength and while the plants are wet with dew. The powder may be puffed on the insects while clinging to shrubbery or on the lower branches of trees. This powder is absolutely worth-

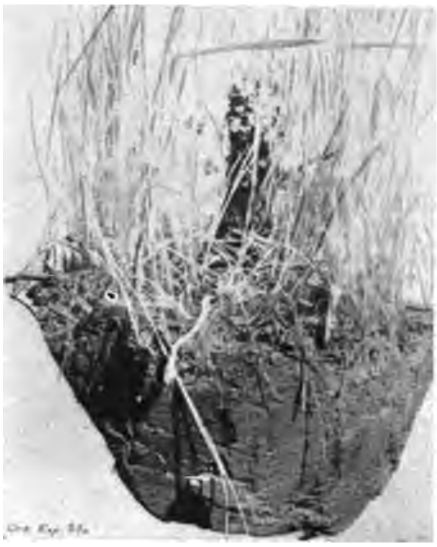


Fig. 2. Periodical Cicada: Section of sod with pupal gallery extension above ground. (Original.)

less against the pupae. Some experiments carried on by the United States government show that newly emerged pupae may be destroyed by spraying with a 2 per cent solution of carbolic acid or a 15 per cent solution of acetic acid.

Coating the trees with whitewash or spraying with a strong solution of lime-sulphur offers a possible protective means against egg deposition, as it has been stated that the cicadas do not like to sit on a white surface.

Phenococcus

P. dearnessi

The immature insects hibernate under the rough bark of apple trees. Eggs are laid in early summer, the young migrating to the under side of leaves. The insect secretes a cottony substance as shown in the illustration.

The usual remedies for scale.

Rabbits

By H. F. Wilson

The first suggestion would be to remove all brush piles and thickets and other places which offer hiding places or may serve as breeding places.

Repellents

Perhaps the easiest to apply and about as efficient as any repellent is the common lime-sulphur spray applied to the trunks of the trees so as to drench them.

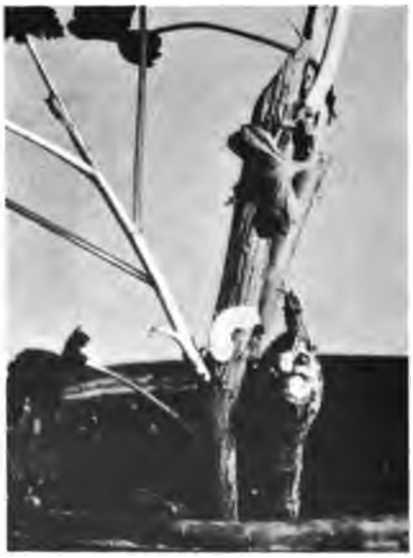
The Arkansas Experiment Station recommends painting the trunks of trees in the fall with white lead and linseed oil. Mixed paints should not be substituted for the above, as they may contain oils which would injure the trees. This seemed to give very satisfactory results and had the advantage of remaining on the trees for an entire season.

The Oklahoma Station recommends the following formula which they found very satisfactory: "Water one gallon, one pound soap, two to four ounces of carbolic acid." Some prefer to add enough vermilion red to give the mixture a good pink color and the consistency of cream. This is painted on the trunk of the trees in the fall with a brush or swab of rags tied to a stick.

Tree Protectors and Wrappers

Wire window screen and fine chicken fence wire may be used with success in case of small trees. They should be about two feet high and should be allowed to stand out a short distance from the tree. The tubes should be fastened with wire.

Wooden veneer strips or some of the ready-made protectors may be used with



Phenococcus dearnessi.

success. In case of veneer they should be soaked in water before attempting to bend them around the trees. Where there are only a few trees, as around the home yard, the most satisfactory method of protection is to wrap them with papers; cornstalks, burlap, etc., may be used, but these must be removed during the summer as they furnish a harboring place for insects.

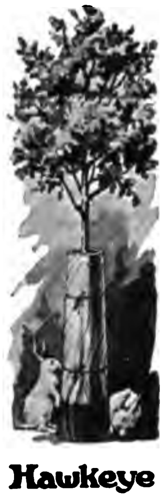


Fig. 1. Veneer Strips of Ready-made Protector.

Traps

There are any number of these which are very easily made and are very effective. This method is not as economical as poisoning but is frequently used.

Poisons

Poisons have the advantage of being easy to make and place, but may be dangerous to domesticated animals. Two formulas are included, any one of which will do.

1. Sulphate of strychnine one part, borax one-third part, white syrup one part, water ten parts. Put the mixture into a jar or large bottle and mix well. Cut fresh twigs, water sprouts of apple are best, and with a small brush paint them, especially over the terminal bud, with the above preparation.

2. The Western Australia Department of Agriculture recommends a similar formula: Dissolve one and one-half ounces of strychnine in one quart of vinegar, dilute with five gallons of water, add two pounds of flour and one pound of sugar, stir well and apply to twig as in first poison.

Railroad Worm.—See *Apple Maggot*, this section.

Red Bug.—See *Apple Red Bug*, this section.

Red-Humped Apple Tree Caterpillar

Oedemasia concinna S. & A.

H. F. Wilson

As yet this insect has not reached a very important status as a pest, but it is more or less generally distributed in fruit growing sections of the United States. At times they may get into an orchard and strip a great many branches, as they are voracious eaters, feeding on apple, plum, cherry, rose, thorn pear, blackberry, birch, poplar, etc.

The adults are moths of rather a mixed brown color, fore wings dark brown on the inner and grayish along the outer margin. The thorax and abdomen are brown. The moths appear in the middle of the summer and deposit their eggs in clusters on the under side of the leaves. From these soon hatch little larvae or worms, which feed on the under side of the leaf. Later as they grow larger, the whole leaf excepting the midrib, is devoured. In October they become full grown, descend to the ground, crawl under leaves or rubbish, where they construct a clear transparent cocoon, and remain until the following spring, when they appear as moths.

The full grown caterpillar measures about one and one-fourth inches in length. It is marked with fine longitudinal stripes of black, white and yellow. Head bright red, and contracting upward and backward. Body covered with black tubercles, which on the dorsum carry black spines.

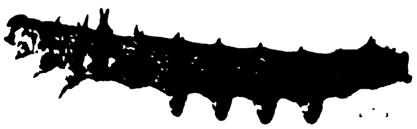


Fig. 1. The Red-humped Caterpillar. (Much Enlarged.)

The fourth body segment is raised dorsally to form an oval red hump from which the insect gets its common name.

Remedies

Arsenicals applied to the leaves are efficient and probably the reason that we seldom hear of this pest doing serious damage is because they are poisoned by the sprays used for codling moth, etc.

Red-Necked Apple Tree Caterpillar

Datana ministra

A moderately large black caterpillar, loosely clothed with soft hairs, and marked with parallel longitudinal yellow stripes. Disposed to be social, but makes no web. Adult a reddish brown moth.

Sometimes attacks a tree or two in nursery or orchard, and then strips whole branches, or the greater part of whole trees, of leaves. The caterpillar when at rest elevates both head and hind end of the body and has a habit of gathering in large masses on the trunks of trees.

The species passes the winter in the pupa stage in the soil under trees, and comes up as a moth in late spring to place its eggs on the leaves.

Not noted in the Northwest.

Burn with kerosene torches or spray with arsenate of lead.

Red or Six-Spotted Spider or Mite

**Tetranychus bimaculatus* Harv.
Tetranychus sexmaculatus Riley

General Appearance

This species (like the other mites) is exceedingly small and individuals are seldom noticed excepting when they collect in great numbers. The color is red with a yellowish tinge and usually with two darker spots on each side of the body. The young greatly resemble the adults but have six rather than eight legs.

Life History

The mites usually begin to appear after the first warm weather in the spring, the winter having been spent in the ground. They spin threads so as to conceal themselves, their eggs and young, on the undersides of the leaves and feed directly upon the tissues of the plant by sucking which gradually stunts and kills the latter. The common red mite is a serious greenhouse pest, where, under favorable conditions, it is able to work throughout the entire year.

Distribution

Though of foreign origin this mite has become thoroughly distributed over the entire state and is met alike in field and greenhouse.

Food Plants

This mite is an omnivorous feeder, apparently without any favorite food. The plants which it is known to attack are sugar beets, beans, sage, tomato, eggplant, pepper, cucumber, squash, cowpea, hops, berries, violet, rose, clematis, mignonette, pink, fuschia, pelargonium, godetia, passiflora, feverfew, thunbergia, verbena, heliotrope, moon-flower, calla, smilax and easter lily.

Fig. 1. Mite Eggs About an Apple Bug.

Control

Sulphur and dehydrated lime mixed in equal proportions and thoroughly sprinkled over the plants are recommended. Sprays such as emulsions, resin wash and soap solutions are efficient remedies, but these are usually too destructive to the tender leaves of the food plants to be practicable. The flour paste spray is especially recommended in such cases.

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*We are informed by Dr. H. E. Ewing that the correct name of this species is *Tetranychus telarius* Linn.

Natural Enemies

The minute black ladybird beetles (*Stethorus vagans* and *Stethorus picipes*) and the larvae of the syrphid flies prey upon this mite.

E. O. Essig

Resplendent Shield Bearer

Coptodisca splendoriferella

This leaf miner attacks apples, quince, and native hawthorns. When the larva is ready to change to a pupa, it cuts out the part of the leaf it has mined and drags it away to the twigs, where it is secured as a small cocoon about one-eighth inch in length, and remains with the enclosed pupa until the following spring.

The larva is legless, flattish, the head dark brown, the body lighter brown with a darker shade along the middle above and beneath.

The adult is a beautiful little moth, the head and outer half of the front wings golden, the bases gray. A silvery streak extends inward from both anterior and posterior margins of the front wing toward the tip, but they do not meet.

The insect is not very common and those I have secured have been badly infested with a small yellow and black Hymenopterous parasite.

H. Garman

Rosy Apple Aphis.—See *Aphids*.

Saddle-Back Caterpillar

Sibine stimulea

A slug-like caterpillar with four conspicuous horn-like spiny processes, one at each side near the front end of the body and the other pair near the hind end. There are other smaller processes at each end. Body purple in front and behind, between, pea-green, with an oval, saddle-like area in the middle of the back, the green surrounding it having some appearance of a saddle blanket. Length about one inch.

The pupa is found in a brown papery cocoon, formed against branches or other objects.

The adult moth expands about 1 44 inch. The fore wings are of a deep reddish brown color; hind wings, much paler.

The insect is never common enough to be the occasion of any anxiety. Besides apple, it feeds upon oak, cherry, corn, and other plants.

The San Jose Scale

Aspidiotus pernicious, Comm.

By H. F. Wilson

Nature and Extent of Injury

One can hardly fail to locate this insect where it is present in unchecked numbers, for the appearance of its host will be such that one who is familiar with the resulting injury can readily distinguish the more or less circular ash-gray, shield-like scales on bark, leaves or fruit. Owing to the fact that the scales closely resemble the bark of most of our fruit trees, they may be working on a tree for some time before their presence is discovered. When they are abundant, the fruit will usually be infested with few to many scales; this is the first indication that the average orchardist will notice. When allowed to develop unchecked, they soon cover branches and limbs, which, as a result of the injury, die in one or more seasons; following this, entire trees die from lack of nourishment.

It has been said that the San Jose scale is the only scale which causes the reddening of the bark, but this is not true as the same effect is caused by other scale insects. This is quite characteristic of

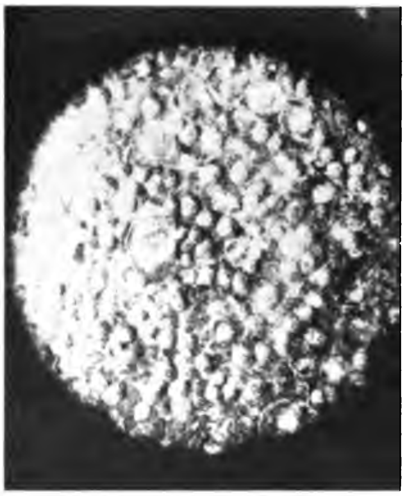

Fig. 1. San Jose Scale. (Enlarged)

the San Jose scale, however, and furnishes a fairly sure basis for identification in the orchard.

The condition of the scales can readily be ascertained by scraping them from a branch; if they are dead, the scales will rub off like a dry, gray scurf; if they are alive, the crushed bodies will produce a yellow oil-like fluid which gives the bark a greasy appearance. Wherever a scale has settled there will be a small round spot with a white speck in the middle; the spot is formed by the body of the scale while the white speck is where the long thread-like piercing apparatus, or tongue, was inserted in the bark. Oftentimes the scales will completely cover portions of limbs and overlap on each other so that they form a crust. When so badly infested, young scales will crawl under old dead scales and settle. We have found as many as four young scales fastened side by side under one old scale. Fruit infested with the scale becomes pitted and gnarled, as the growth is checked at the point where the scales have their beaks inserted.

"For the benefit of fruit inspectors in particular, it should be noted that reddish discolorations upon yellow fruit are not always caused by San Jose scale. Upon yellow apples and particularly upon peaches very similar spots are produced by attacks of certain minute fungi. Hence, such spots should not in themselves be taken as proof of infestation by the scale. This can be determined definitely only by a careful examination and the actual detection of the scale. The presence of such blotches may well arouse suspicion of the presence of San Jose scale and should challenge a careful examination alike by growers, buyers and inspector; so, also, should the presence of dead and shriveled leaves upon the trees in mid-winter invite examination, for, although their presence is not proof of the appearance of the scale, it is evidence that the vitality of the tree has been seriously impaired by some cause, and in regions where San Jose scale is prevalent that cause, in a vast majority of instances, is the scale." (1)

Unlike most other scale insects, it develops and hatches its eggs within the body, so that the young are born alive. In May, possibly earlier, under favorable conditions, the females begin to give birth to living young and may continue to produce for six weeks or longer.

General Description

The young are minute, light orange yellow, active creatures with eyes, bristle-like mouth parts, two antennae or

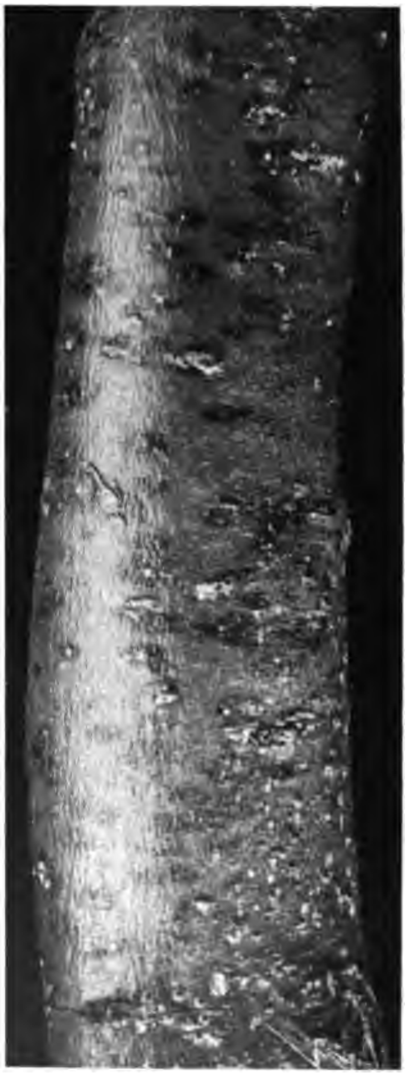

Fig. 2. San Jose Scale on Apple Limb. (Purdue Bulletin 138.)

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(1) A. B. Cordley, Bull. 88, Ore. Agr'l Ex. Sta., p. 6, March, 1906.

feelers, and six legs. After emerging from under the protecting scale of the parent, each wanders over the surface of bark, fruit or leaf until a suitable situation is found, when the legs and antennae are folded beneath the body, the bristle-like beak is slowly worked through the outer bark into the living tissues beneath, from which it draws its sustenance. At any time during the summer months hundreds of these little pests may be seen, even with the unaided eye, as they crawl about over the bark or fruit of infested trees. With the first molt, all appendages, the legs, antennae, etc., except the beak, are lost.

The female scales when mature have a more or less circular scale formed of a number of concentric rings, which correspond to the various molts made during growth. Under a strong lens these appear ash-gray in color with a black protuberance or raised spot in the middle.

Remedies

In this state lime-sulphur is generally used in combating the San Jose scale. The recommendations from this station have been to spray the trees while dormant either in the late fall or early spring.

"During the past four years we have conclusively demonstrated that the lime-sulphur spray, which has long been known as the most satisfactory winter spray for San Jose scale, has fungicidal qualities nearly or quite equal to those of Bordeaux. We have also conclusively demonstrated that it may be used in combination with arsenate of lead without detracting from the value of either, and that when so used it is at once an efficient contact insecticide, food poison spray and fungicide." (2)

We have also demonstrated the fact that Black Leaf or "Black Leaf-40" can be combined with lime-sulphur, in control of plant lice without destroying the insecticidal value of the lime-sulphur. The most suitable time to get plant lice is in the spring, just as the buds are turning green. At that time a very large percentage of the eggs will have hatched and the young lice will not be protected by the leaves. The lime-sulphur is equally as effective in the control of the scale when applied at that time and to a slight degree may be effective against the newly hatched lice.

General Recommendations

It is not necessary to make an application of lime-sulphur for the San Jose scale alone. If lime-sulphur is used at any time for the control of apple scab or anthracnose, the same application will suffice for the control of the scale.

In regions where neither of the above diseases exist, spray with lime-sulphur, winter strength, just as the buds are opening, and if the plant lice (any species) have been bad during past seasons, add "Black Leaf-40" at the rate of 1 part to 900 parts of the diluted lime-sulphur spray.

Scurfy Scale

Chionaspis furfura Fitch

General Appearance

The female scale is irregular and broadly pear-shaped; from white to light gray in color. The exuviae is yellowish and from one-eighth to one-tenth of an inch in length. The male scale is white, very small, long, tricarinated and with yellow exuviae at the pointed end.

Life History

The winter is passed by the females under the scales where the purple or wine-colored eggs are laid and hatch in the spring shortly after blooming time. The young begin at once to cover their bodies with a scale.

This insect is sometimes confused with the oyster shell scale, but is broader and much lighter in color, having dark red eggs, while those of the oyster shell scale are yellowish-white.

Food Plants

This species attacks many plants, chief of which are apple, pear, plum, cherry, quince, Japanese quince, currant, mountain ash, hawthorn, peach, poplar, gooseberry, crabapple, chokecherry, black walnut and elm.

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(2) A. B. Cordley and H. S. Jackson, Cir. Bull. No. 13, Ore. Agr'l College, 1911.

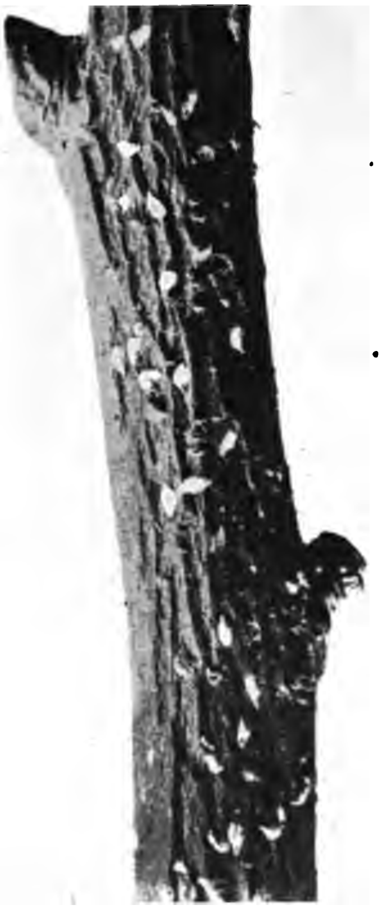

Fig. 1. Scurfy Scale. Purdue Bulletin 118.

Control

Same as for San Jose scale.

E. O. Essig

Seventeen-Year Locust.—See *Periodical Cicada,* this section.

Six-Spotted Spider.—See *Red Spider,* this section.

Syneta.—See *Fruit Tree Leaf Syneta,* this section.

Tent Caterpillars

Malacasoma erosa Stretch.
Malacasoma pluvialis Dyar.
Malacasoma constricta Stretch.

By H. F. Wilson

Tent caterpillars, so-called because they build nests wherein they usually remain when not feeding. These nests are formed out of silken threads secreted by the larvae and serve both as a shelter and a protection against natural enemies.

Of the many different species which exist throughout the world only three are at all serious in the Northwest. To the casual observer there is little difference between the larvae and adults of these species when looked at separately. Taken side by side, however, the full-grown larvae may be easily distinguished, one species from the other.

*According to Professor F. L. Washburn, a former entomologist of the Oregon Agricultural College, of the three, ***Malacasoma erosa, Malacosoma pluvialis,*** and ***Malacasoma constricta,*** the first named feeds upon almost everything but the pear, viz.: apple, quince, cherry, rose, prune, etc. The second has about the same food plants as the first. The third devastates whole groves of oak, particularly ***Quercus garryana,*** occasionally migrating to the prune, and thereby causing considerable alarm among orchardists.

During the past two or three years ***M. pluvialis*** has been extremely abundant in the western part of Oregon, both on fruit and forest trees. Numerous reports have come in from about Portland and I have observed the larvae over many square miles of woodland in Southern Oregon.

When these larvae are very numerous they can entirely strip a tree of its foliage in a very short time. When first hatched from the eggs they are not readily noticed, but as they grow larger they are readily distinguished both by their size and by the tents which they build. Toward the middle or latter part of the summer the larvae become full grown; they then seek crevices where they spin silken cocoons and change to pupae. After remaining in this stage a short time they change to the adult insects or moths which come forth and deposit the eggs. The eggs are deposited in masses on the small branches or shoots, and in the case of one species, where the eggs are laid on new shoots, the egg mass completely surrounds the twig. These are covered

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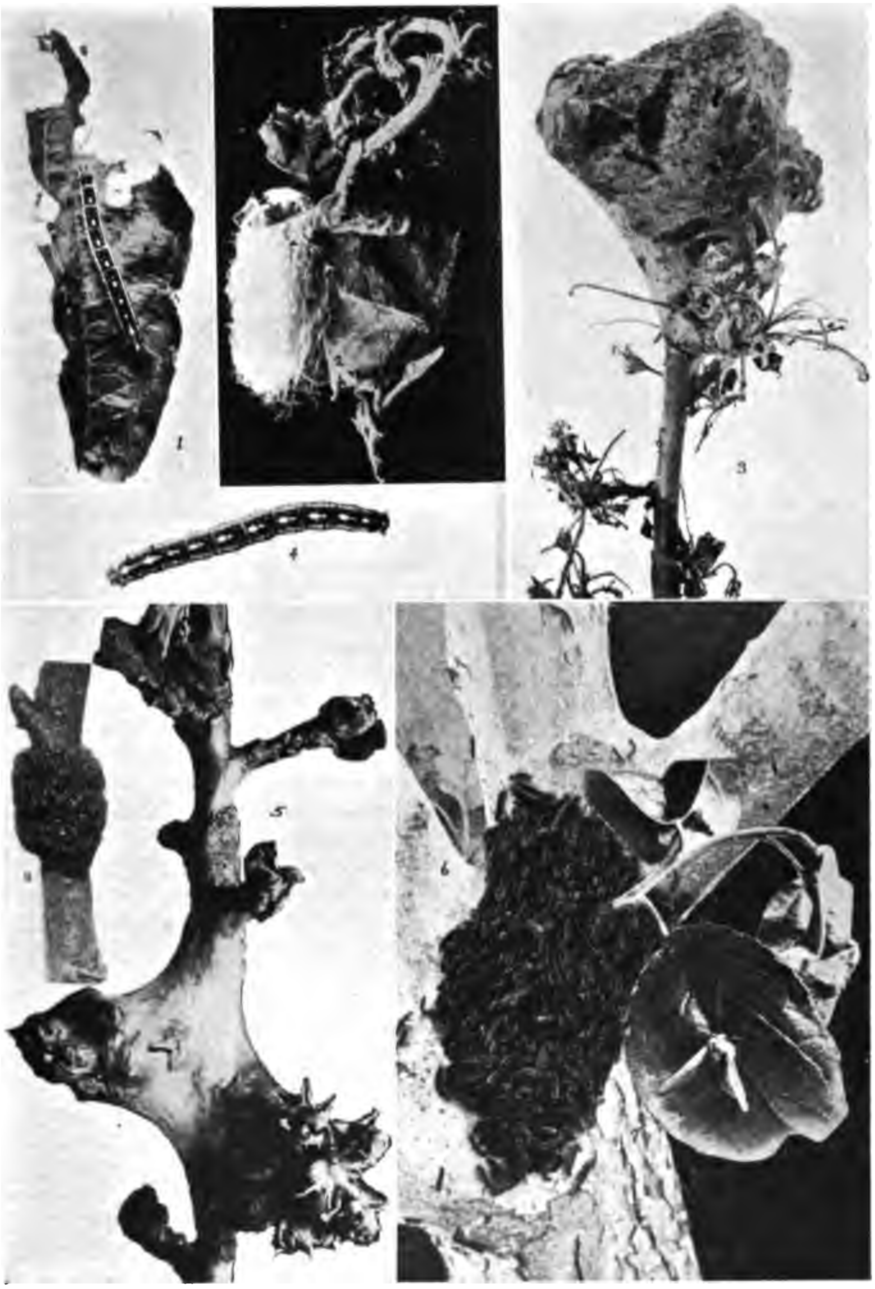
*F. L. Washburn, Bulletin 33, Oregon Experiment Station, 1894.



Tent Caterpillars. 1 and 4, larvae of *M. erosa;* 2, cocoon of *M. erosa;* 3, tent of *M. erosa;* 5, egg mass and nest of *M. pluvialis;* 6, cluster of caterpillars on trunk of apple, *M. erosa;* 7, adult of *M. erosa;* 8, egg mass of Western Apple Tree Tent Caterpillars.

with a cement-like substance which is impervious to water and climatic conditions. This gellatinous substance, besides acting as a protection to the eggs, is said to constitute the first food of the newly hatched larvae. The embryonic larvae in these eggs are nearly full fledged at the beginning of winter and usually come forth from the egg mass early in the spring. All of the moths do not emerge at the same time, so that we may find them laying their eggs until late in the fall. The eggs of the late appearing moths do not hatch until a correspondingly late period in the summer; therefore, we may find some caterpillars and nests all through the summer. This might seem to indicate that there is more than one generation a season but such is not the case. The adult moths are about one inch long and are cream colored with indistinct white bands on the wings.

Natural Enemies

Like every other species of animal life these insects have their natural enemies, and large numbers are destroyed each season. Few birds feed upon hairy caterpillars, but according to Professor Washburn, the Brewers' Blackbird, very common in this country, is very fond of the pupae, and may be observed tearing open the cocoons and feeding on them. They are also attacked by a fly, which lays eggs on the larvae. From these hatch minute worms which bore into the insects and feed on the tissues, thus eventually killing the host. There is a fungus disease prevalent in Oregon which is very disastrous to the insects under the right condition. This is induced by warm wet weather when the larvae shrink up and die.

Artificial Methods of Control

In fruit orchards, spraying with arsenate of lead, as used for the codling moth, is usually sufficient. As the egg masses remain over the winter on the twigs the majority of the nests can be destroyed at the time of winter pruning. If these nests are not located in the winter and the caterpillars form tents in the spring, the tents can be burned out with a torch. Shade trees may be protected by spraying with arsenate of lead, 2 pounds to 50 gallons of water.

TINGIS.—See *Apple Tingis*, this section.

Trumpet Leaf Miner of the Apple

Tischeria malifoliella Clemens(?)

H. F. WILSON

This insect is of little economic importance to fruit growers in the Northwest, but sometimes appears very numerous on the leaves of apple and is often inquired about.

Little mines are made in the leaves by the larvae, which begin at the point of egg deposition and gradually widen out in the shape of a trumpet. Completed mines vary much in shape and size, but will average perhaps in the more typical examples one-half inch long by one-fourth inch wide.

The larva is whitish in color with a brown head, and measures about one-quarter inch in length at the time of pupation. The adult was originally described as follows: "The head and antennae shining dark brown, face ocherous. Fore wings uniform shining dark brown with a purplish tinge, slightly dusted with pale ocherous citio of the general hue. Hind wings dark gray; cilia with a rufus tinge."

When excessively abundant, as has been the case in several localities during the past two or three years, the injury done by the larvae to the leaves will cause many of them to fall prematurely, thus interfering with the proper development of the fruit and the health of the tree. Its control, therefore, becomes a matter of importance. This can, perhaps, best be accomplished by plowing the orchard in the spring, covering as much as possible all the fallen leaves and trash, as in the former the pupae pass the winter. This having been done it is practically certain that the moths will not be able to make their escape from the soil. This should be done not later than the blooming of the trees.

TUSSOCK MOTH.—See ***Western Tussock Moth***, this section.

TWIG BORER.—See ***Branch and Twig Borer***, this section.

Unicorn Prominent

Schizura unicornis

During August and September, a singular caterpillar is occasionally found feeding on apple foliage. It is reddish brown, variegated with white on the back, and has a green patch on each side, extending over the second and third segments, while from the top of the fourth a conspicuous horn is projected. It eats out a notch from the edge of the leaf and then fits itself to the notch, clasping the eaten edge of the leaf with its prolegs while the prominent horn is made to extend over a portion of the vacant space where belonged the devoured tissue. The outline of the back, thus simulating the irregular edge of the leaf, enables the caterpillar to elude the sight of all but the most searching eyes. This caterpillar is known as the unicorn prominent, and though interesting, rarely, if ever, becomes sufficiently numerous to be troublesome. It reaches full size in September and descends to the ground, where a cocoon is constructed under the fallen leaves and trash. The light-brown moth does not appear until the following summer. No measures against this insect are needed under ordinary circumstances. If a midsummer spraying with arsenate of lead is made in July or August, these caterpillars are apt to be thinned down until they attract no notice.

H. A. Gossard,
Wooster, Ohio.

Weevil.—See *Bronze Apple Tree Weevil*, this section.

Western Tussock Moth

Hemerocampa vetusta Boisd.

H. F. Wilson

The distribution of this insect in the United States is at present limited to the Pacific coast, and on account of the similarity of its work to that of the tent caterpillars, is often taken for one of those insects. The two are quite different, however, in appearance, both in the larval and adult stages.

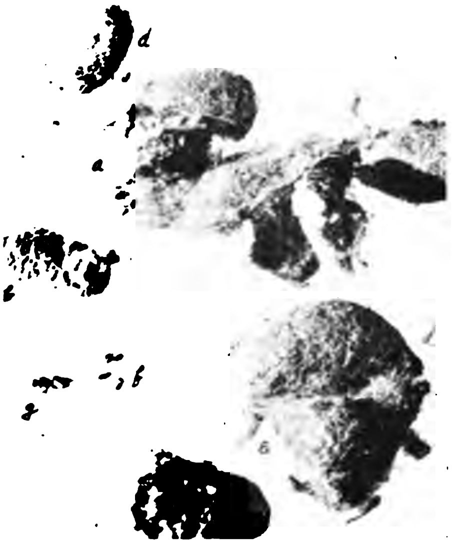


Fig. 1. Western or California Tussock Moth. (a) and (b) Adult wingless females. (d) Cocoons. (e) Egg masses attached to the cocoons. (f) Eggs. (g) Internal parasite working upon cocoons. (Essig.)

The eggs begin to hatch about the time the leaves are spreading out in the spring, and at that time the young larvae are almost black. For a few days they remain clustered about the egg mass and apparently feed on the substance which covers and holds the latter together. After the larvae have all hatched and have broken out from the eggs, the egg mass will appear as if riddled with holes. The larvae cut these in escaping from the eggs.

After a few days the larvae spread on to the nearby buds and leaves. At first the damage is very slight and consists of minute holes in leaves, blossoms and fruit. Later they feed entirely on the leaves which they devour, leaving only portions of leaves and the larger veins.

Unlike the larvae of the tent caterpillars, they spread out over the tree and do not collect at night nor do they build nests or tents. They are somewhat wandering in their habits and oftentimes can be seen crawling about on the ground, going from one tree to another.

The original description of the larvae is given as follows: "Ground color velvety black. Head black, rather shining, with yellow line in front. From the second segment springs two bundles of long black hairs. The space between these is bright vermilion red; at the base of each

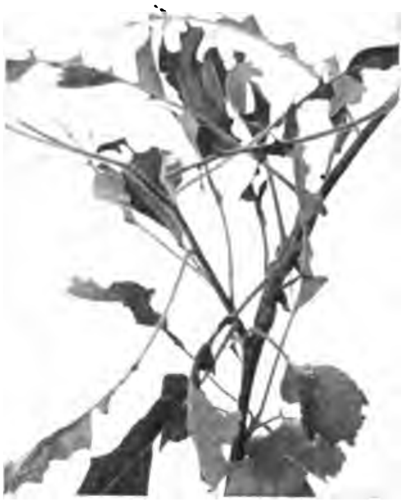


Fig. 2. Western Tussock Moth: Larva feeding on Apple Foliage. (Original.)

segment is a series of four or five orange yellow dots, extended to the sides; third and anterior part of fourth more broadly and distinctly patched with orange. From the dorsum of fifth, sixth, seventh and eighth spring bundles of long silky hairs, whitish drab at their base, chestnut towards their tips. Along the lateral region is a double row of bright red tubercles, and on the third, fourth, tenth, eleventh and twelfth, these extend across the body, six tubercles appearing on each segment. Out of these spring a series of long yellowish white hairs, sparsely interspersed with black, and becoming more decidedly yellow laterally. From the center of twelfth segment a bundle of long yellow hairs, tufted with black; under side blackish; feet and pro-legs orange yellow, with the claws black. Length one inch."

When mature the larvae usually seek some protected place for forming their cocoons and in such a place collect in large numbers if very abundant. Occasionally they will gather bunches of leaves at the tip of twigs and form their cocoons under these; this takes place in early June. About the last of June the females and males emerge, copulate; and the females being unable to fly, remain hanging to the old cocoons. The males fly both at night and during the day; they live but a short time after copulation.

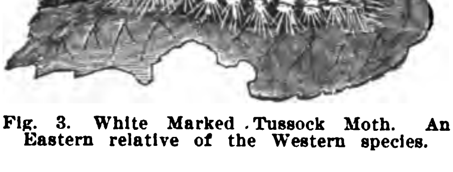


Fig. 3. White Marked Tussock Moth. An Eastern relative of the Western species.

It has been stated that the males are attracted to the females by their odor and that they will go long distances to find them. As the eggs are deposited the females secrete a cement-like substance which surrounds the eggs and forms an excellent protection against climatic conditions and enemies. This also fastens them very securely to whatever they are laid upon. As the eggs pass from the body the abdomen contracts until the female is but head and legs with but a semblance of an abdomen. The egg masses are grayish brown in color, nearly spherical and measure about one-fourth inch in diameter. There is but a single brood each season and the eggs remain over until from early summer to early spring. There is little danger that this insect will ever become a very serious pest but it is at all times annoying and may at times need special treatment.

Remedies

Our most common spray of arsenate of lead, 2 pounds to 50 gallons of water, is

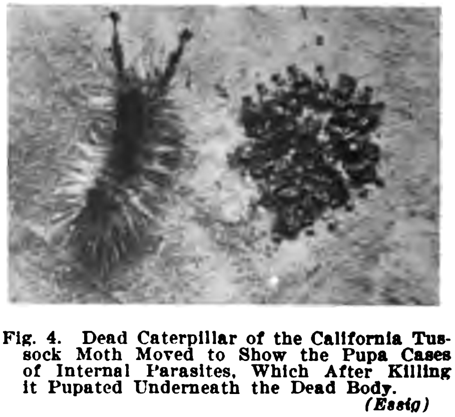


Fig. 4. Dead Caterpillar of the California Tussock Moth Moved to Show the Pupa Cases of Internal Parasites, Which After Killing it Pupated Underneath the Dead Body. *(Essig)*

entirely ineffective and Paris green is not much better. Contact sprays seem to be inefficient and there remain but two methods that offer any great chance of success; one is to collect or to destroy the egg masses.

Second, by placing sticky bands on the trees and then jarring the trees. These may be made of tangle foot or some tar compound. Jarring the trees will cause the larvae to drop to the ground and when the trees are banded they cannot get past the bands as long as they remain fresh.

White Dotted Apple Worm

Balsa malana

In early fall and continuing until late autumn may sometimes be found a rather stout, cylindrical, light-green worm, about an inch long and marked with five white longitudinal lines and numerous whitish dots. These worms are in the habit of feeding solitary and alone on the underside of the leaves, from the margins of which they eat regular notches or holes into the middle. This caterpillar is known as the white dotted apple worm. When full grown, the caterpillar draws together a portion of the leaf with silken threads to form a hollow tube. This is lined with a thin layer of silk and the caterpillar then passes into the pupal stage. The chrysalis remains in the fallen leaf until the next spring, when it issues as an ashy gray moth with three irregular black lines crossing the front wings. There are two broods.

H. A. GOSSARD,
Wooster, Ohio.

WILT BUG.—See *Apple Wilt Bug*, this section.

WOOLLY APHIS.—See *Aphids*.

A Japanese Formula for Destroying the Woolly Aphis

Mr. T. Machida of Japan has recently found a very satisfactory wash formula which has been found to be of much value in the control of the woolly apple aphis. His recommendations for the various ingredients to be used are as follows:

Rape-seed oil	3 1/3 pints
Sulphur	1 1/2 ounces
Turpentine	7 1/3 ounces

The rape-seed oil should be boiled alone for a very short time followed by adding the turpentine slowly, stirring continually until they are thoroughly mixed. Stir in the required amount of well crushed sulphur. Use a strong fire and allow to cool, when the mixture assumes a darkish color. Paint the attacked parts of fruit trees. This wash can also be recommended for use in the control of other aphids and the destruction of their eggs.

S. NAKAYAMA,
Stanford University.

California Com. Hort., III., No. 2.

Yellow-Necked Datana

D. ministra

Often conspicuous and quite injurious in September. Most of the caterpillars are well grown before the middle of the month and are ravenous feeders upon apple and other orchard and forest trees. The full-grown caterpillar is about two inches long with a black head and a yellow neck. A black stripe extends down the middle of the back and three stripes of the same color, alternating with four yellow strips, extend along each side. The body is quite hairy. The caterpillars are gregarious and collect together in large numbers out towards the ends of the twigs. If the branch is jarred or the caterpillars are in any way disturbed, they cling for support with their four middle pairs of legs, and elevate both ends of their bodies in the air at right angles to their support. Some time in September, they all descend to the earth and burrow beneath the surface from two to four inches, where they pupate. When the colonies are young, they are confined to a single small branch, which may be cut off and burned. After they become more mature, resort to hand-picking or spray the trees on which they are feeding, if not carrying fruit, with arsenate of lead, 5 pounds in 50 gallons of water. Kerosene emulsion may be diluted with 12 to 15 parts of water and sprayed directly on them. Make oil sprayings only on dry, sunshiny days so as to avoid all danger of injury to the foliage. The raincrows or cuckoos feed quite freely on these hairy caterpillars, which are shunned by most birds.

H. A. Gossard,
Wooster, Ohio.

Apricot

The apricot is related to the peach, plum, almond, nectarine, cherry and prune. It is generally believed to have been a cross between the peach and the plum; but this has been disputed on the ground that it grows wild in Africa and the Caucasus mountains. In some parts of the Caucasus mountains the hills and mountainsides are covered with apricot trees, and in China also it grew wild at an early date. Its origin is, therefore, involved in mystery, and perhaps with our present information, cannot be definitely settled.

In growth, habit and the soil to which it is adapted, it is much like the peach; matures its fruit about the same time; the tree is not quite so tall; blooms a few days earlier, and is a little more likely to be killed by frost. In shape and color it resembles the peach; but in texture and the smoothness of its skin, it is more like the prune and plum. The bark of the tree is similar to that of certain varieties of cherry; its leaves are heart-shaped, bright green and yellow. It requires about the same kind of soil and cultivation as the peach, which see.

The apricot is regarded as a tenderer fruit than the peach, but this is doubtless due to the fact that it blooms earlier. It is not so profitable commercially. For this reason growers have not made such efforts to produce late blooming varieties. The peach is larger, has more varieties of flavor, therefore brings a better price in the markets, yet apricots are appreciated for canning purposes.

California produces more apricots than any other state in the Union. The apricot was introduced into California, by the Mission Fathers, where it was found in the Santa Clara valley in 1792. The varieties found there were not of high grade, generally seedlings, and much inferior to those introduced later by gold seekers from England and France in 1850 to 1860.

The Soil Best Adapted

The apricot will stand more humus, or a stronger soil than the peach. In the article on the peach it has been observed that this fruit will not endure a soil very rich in barnyard manure or other fertilizers. In the growing of cover crops in the orchards, it has been discovered that the peach is injured by a quantity of nitrogen and humus, that will give health and vigor to apples and pears. The apricot will stand more of these fertilizers than the peach, but like the peach, it requires a light dry soil, and a mixture of sand and gravel is beneficial.

The root system is not particularly strong, therefore, the soil should be loose and deep enough so that the roots will penetrate it without the energy necessary to break it up. It requires less water than apples and pears, and, therefore, the water should not be allowed to stand on the ground, or the soil to water-log. What we have said applies mostly to the improved varieties, rather than to the seedlings which grow with great vigor, and have great resisting power. These seedlings have sometimes a fruit of fine flavor, but very small as compared with the Moorpark or other improved varieties. In this, the apricot follows a general rule, for it is true of peaches, apples and other fruits that the trees which are the most hardy and resistant to injuries generally produce the poorest fruits.

Apricot trees are produced by budding on peach or apricot seedlings during the first summer's growth in the nursery row. These seedlings are produced either from peach or apricot seeds, planted during the preceding winter. As to the method of planting, see article on the peach. The tree is a vigorous grower, and must be carefully pruned to shape the top and to prevent the dwarfing of the fruit by an extra heavy crop. This method of pruning will also lessen the work of hand thinning. However, where the fruit is so close that the apricots crowd each other, hand thinning is necessary to the production of the largest and most profitable commercial grades. It is better to have a certain quantity, say 100 pounds or four boxes, of large, well-developed and well-formed fruits, than to have the same number of pounds or boxes of small fruits, some of them malformed because of crowding.

Varieties

The best variety grown in the Northwest is the Moorpark. In all the Pacific coast states, as California, Oregon and Washington, the Moorpark takes the first place and brings to the growers the most money in proportion to the labor and expense of growing. It is a vigorous grower, begins to bear at the age of two years, is large, well-flavored and much in demand.

Apricots are used mostly for canning and for drying. For special information on these subjects, see articles on Canning and Evaporating.

GRANVILLE LOWTHER

Propagation of Apricots

The apricot is like the apple, in that it will not come true from the seed, and therefore must be propagated by budding or grafting, the former being almost exclusively employed. For the best results, seeds should be stratified in sand and frozen during the winter, as described for apples. Apricot seed, however, being larger and more able to meet adverse conditions than the apple, are sometimes planted in the fall in well-prepared ground. Here they freeze and come up without delay in the spring. If stratified for freezing (see *Apple*), they should be planted in early spring before they have begun to sprout. The young seedlings are to be given good culture during the summer, but are not to be dug up in the fall like apple seedlings. If they are to be budded, the work should be done about the first of September, during the first season's growth. If it is desired to graft them, the seedlings should be cleft-grafted near the ground in early spring, at the beginning of the second season's growth, under conditions already described for the apple. If buds fail to take in the fall, the stock may be grafted the following spring. One year's growth, after being either budded or grafted, should make sufficiently large plants for setting them in the orchard. For details of budding, see discussion under the peach.

The apricot is often budded upon the peach, as the latter thrives upon a greater variety of soils than the apricot. The common plum makes an excellent stock for the apricot where it is grown in wet situations.

W. L. HOWARD

Varieties of Apricots and Synonyms

Acme, *Chinese*, *Shense;* Alexander, *Russian No. 2;* Blenheim, *Shipless;* Berda, *Annas*, *DeHollande;* Cluster; Early Golden, *Dubois;* Harris, *Harry Hardy;* Hem's Kirke; Large Early, *Gos Precoce;* Moorpark, *De'Nancy;* Newcastle, *Newcastle Early;* Orange, *Early Orange;* Peach, *Peach Royal;* Russian; St. Ambroise; Sheridan; Surprise; Tilton.

The very early varieties are the Harris, Hem's Kirke and Royal.

The early varieties are the Acme, Early Golden, Large Early and Peach.

The Moorpark is one of the best varieties for the Northwest and is medium early.

GRANVILLE LOWTHER

DATES FOR PICKING IN VARIOUS PARTS OF YAKIMA VALLEY, WASH.

VARIETY	TIME PICKED IN EACH DISTRICT AS SHOWN BY THE FOLLOWING					SIZE	COLOR
	White Bluffs Hanford and Kennewick	Parker and Donald	No. Yakima	Buenna, Zillah Granger, Sunnyside, Donald Grand, Prosser	Selah Naches		
Moorpark	7-17 to 7-27	7-26	7-24 to 8-16	7-19 to 8-12	8-10 to 8-18	Very Large	Yellow Blushed
Royal	7-17	7-15	7-15 to 8-3			Large	Dull Yellow, Mottled with Brown
Russian	7-17 to 8-2					Small	Yellow
Tilton	7-17		7-24 to 7-30			Large	Yellow
Yakimine			7-10 to 7-26		7-12 to 7-20	Very Large	Greenish Yellow, nearly covered with Brown
Nectarines	8-14		8-14 to 9-12		8-28		

APRICOT DISEASES

Brown Rot

Sclerotinia fructigena

A decay of the fruit while still on the tree, occurring some seasons in moist localities. The young growth as well as the fruit is also sometimes affected, the new shoots wilting and dying back from the attacks of this fungus. This is the most serious obstacle to stone fruit production in the Eastern states, but does not find sufficient moisture for its development in the arid West, except on early varieties in occasional seasons of late rains in the moister localities.

Spraying with self-boiled lime-sulphur just as the fruit is setting and again with the same following subsequent rains is recommended for trial.

Ralph E. Smith,
Berkeley, Cal.

Bud Blight

Characterized by a dying of the buds during the early winter and caused very largely by the fungus responsible for Peach Blight.

Similar trouble is caused more or less by "Sour Sap" conditions.

See Blight under *Peach.*

Fruit Drop

The fruit falls to the ground while still very small. Partly due to weather conditions and partly to lack of cross pollination, which can be secured by mixing varieties in planting. Seasonal conditions such as heavy rains at blossoming time or frosts may have this effect. The cherry, almond, peach and pear are affected in the same way.

The drop may not occur until the fruit reaches some size.

See general article on Setting and Dropping of Fruits under *Fruits.*

Fruit Spot. See *Blight* under *Peach.*

Gummosis. See *Cherry.*

Scab

Cladosporium carpophilum

Same as Peach Scab, which see.

Blossom Rot

Sclerotinia

The young fruit decays while still very small and enclosed by the calyx or outer cup of the blossom. The trouble occurs when wet rainy weather prevails during the time of fruit setting. It commences in a rotting of the calyx cup, which is dead and susceptible to decay by saprophytic fungi, which decay spreads to the young fruit. It is caused by various fungi, of which perhaps a species of *Sclerotinia*, apparently *S. libertiana*, is most common, causing a decay of the young fruit on the tree. When such fruit is picked and placed in moist chamber it develops an abundant cottony mold in which black sclerotia soon forms. This appears to be the same fungus causing the cottony mold or white rot of the lemon storage. *Botrytis vulgaris* is also common in this trouble. Same treatment as brown rot.

Spraying for shot hole fungus might also be of some benefit in this trouble.

Shot Hole and Fruit Spot

Coryneum beijerinckii

This fungus is the same as that causing the peach blight and produces in the apricot a spotting of the fruit, shot hole effect in the leaves and killing of the buds.

Spray with Bordeaux mixture during November and again in spring just as the buds open.

See *Blight* under *Peach.*

Sour Sap and Seasonal Effects

The apricot is particularly sensitive to sour sap and other seasonal effects. It is a tree having a free flow of sap, quick to respond to stimulating influences and one having the characteristic of all the stone fruits of forming an abundance of gum when injured in any manner. On this account, if any active movement from the roots is started early in the season by warm weather or an abundance of moisture and this activity be checked again by less stimulating weather conditions, trouble is very apt to follow. The sap becomes stagnant in the tissues, full of sugars and other easily fermentable substances, gum begins to form, sunburn may also occur and very often severe injury takes place in the tissues of the sap wood and cambium layer.

Ralph E. Smith,
Berkeley, Cal.

APRICOT PESTS

The apricot is not the particular host of a large number of insects. In general its enemies are those common to other fruit trees of the same family.

Black Scale

Saissetia oleae Bern.

General Appearance

Black, oval, tough-skinned scales with a distinct "H" on the back of half and full grown females. From one-eighth to one-fourth of an inch in diameter. The young vary from light yellow to brown. The males are very minute and scarcely ever seen. The eggs are nearly globular and slightly amber in color.

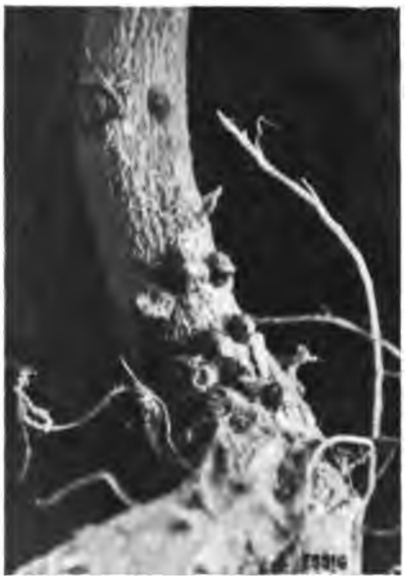


Fig. 1. Full Grown Specimens of Black Scale, *Saissetia olcae* (Bern.), at base of nightshade plant. Many of these were under the surface of the soil. (Essig, P. C. Jr. Ent.)

Life History

The females deposit from 50 to 300 eggs, covering a period of from two to four weeks. The most are laid during the months of May, June and first half of July, though in some sections all stages of the insect may be found. Young half-grown scales are most abundant from September 15th to December 15th and the full-grown females from February 15th to July 15th. They work principally upon the leaves of the trees, when they are young, but later are found almost wholly on the limbs.

Food Plants

All citrus trees, olive, apricot, guava, honey locust, Irish juniper, pomegranate, Lombardy poplar, apple, prune, plum, almond, pear, sycamore, oleander, pepper (*Schinus molle*), sumach, (*Rhus*), mountain holly or Christmas berry *(Heteromeles arbutifolia)*, *Baccharis viminea*, rubber tree, *Habrothamnus*, *Myoporum*, *Melaleuca*, laurel, holly, beech, ash, buckthorn, maple, *Grevillea*, *Ligustrum*, nightshade, *Antidesma*, *Duranta*, *Grewia*, *Thespesia*, *Cajanus*, magnolia, eucalyptus, grape, camellia, phlox, watermelon and asters.

Control

Fumigation: On citrus trees fumigate with from one-half to three-fourths schedule No. 1, between September 1st and January 1st. If the hatch is very even and the work can be done early, the one-half schedule is sufficient, but for ordinary work three-fourths of the schedule is required.

Sprays: On deciduous fruit and olive trees the following sprays may be used when the scales are not more than half grown: Water distillate caustic soda mechanical mixture and distillate emulsion.

Natural Enemies

The ladybird beetles, *Rhizobius ventralis*, steel blue (*Orcus chalybeus*), *Olla plagiata* and *Axion plagiatus* work on the young scales; the parasites, *Scutellista cyanea* and *Tomocera californica* Haw., on the eggs and the internal parasite, *Aphycus flavus* How., on the male scale.

E. O. Essig

Common Termite

Termes lucifugus Rossi.

General Appearance

The workers of this species are rather small, being shown as natural size in Fig. 1. They are transparently white in color, the contents of the alimentary canal giv-

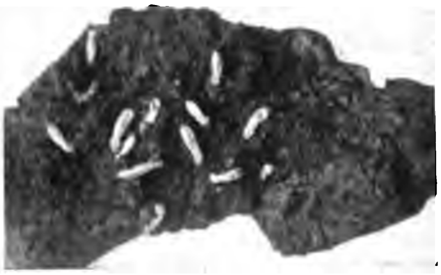


Fig. 1. *Termes lucifugus* Rossi. Working on Roots of Nectarine Tree. (Original.)

ing a yellowish or brownish cast. The head is darker yellow and mandibles brown. The soldier ants have large brown heads, comprising at least one-third of their entire bodies. The queen ant is much larger than the other forms, while the males are small. It is claimed that there are no less than 15 kinds of individuals in this species.

Life History

These termites usually live in dead or decaying wood but often work into the living and growing tissues. They make very extensive galleries through all parts and thus often destroy buildings, fences, etc., as well as fruit trees. The queen gives rise to all the young, which appear in great numbers, especially during the summer months. In the fall or autumn winged or migratory forms appear and often fly by thousands on dark days and towards evening. In habits and life history they greatly resemble true ants and bees.

Distribution

General.

Food Plants

As previously stated, these termites usually work upon dead or decaying wood, but then usually only in the presence of moisture. These insects often become destructive to fruit trees, working upon the roots underground and making galleries up the trunk. No doubt they usually begin to work in the decaying tissues but often continue into the healthy portions of the tree. Nectarines, peaches and apricots seem to suffer most, while citrus and other trees and plants are also attacked.

Control

Due to their secluded work the damage is usually done before their presence is known and too late to effect a remedy. However, if close observations are made in infested districts and their work discovered the colony may be almost entirely exterminated by the use of a liberal dose of carbon bisulfid applied in cotton or a sponge directly within their burrows or under the base of the tree.

E. O. Essig

Brown Apricot Scale (*Eulecanium armeniacum* Craw.) (*Lecanium corni* Bouche). See *European Fruit Scale* under *Apple.*

Canker Worms. See under *Apple.*

European Fruit Scale. See under *Apple.*

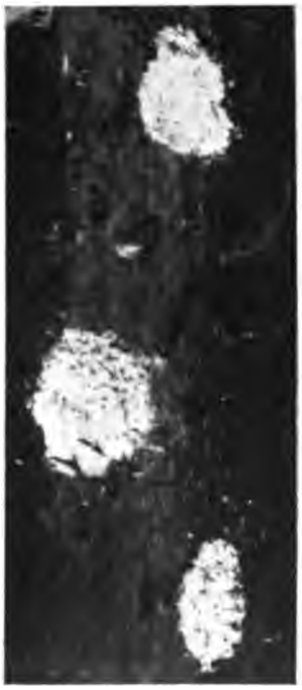


Fig. 1. Immature Specimens of the Frosted Scale on Loganberry Cane. (Original.)

Frosted Scale

Eulecanium pruinosum Coq.

General Appearance

This is one of the largest unarmored scales, often one-half inch in length and three-fourths inch wide. The full grown scales are nearly hemispherical in shape, while the young and half-grown forms are very flat. (Fig. 1, p. 551.) The surface is covered with white frost-like wax, which readily distinguishes it from all other common species.

Life History

Eggs are white to yellowish in color and are deposited in the early summer months. The species is not as prolific as many of the others of this genus, and because of parasites scarcely does any damage.

Distribution

Throughout the central and southern parts of California.

Food Plants

Apricot, prune, peach, plum, cherry, pear, apple, walnut, laurel, ash, birch, sycamore, cork-elm, grape, rose, orange, loganberry and hawthorn. The branches are usually the parts attacked.

Control

Same as for European fruit scale (*Lecanium corni*). See *Apple.*

Natural Enemies

Comys fusca and at least two other internal parasites were bred from this species, and keep it in complete subjection.

E. O. Essig

Mealy Plum Louse. See under *Plum.*

Peach Borer. See under *Peach.*

Pear Thrips. See under *Pear.*

Plum Curculio. See *Curculio* under *Apple.*

Shot Hole Borer. See under *Cherry.*

Termite. See *Common Termite,* this section.

White Peach Scale. See under *Peach.*

Arkansas

Arkansas has a good soil, a humid climate, and many natural sources of wealth. It is adapted to the growing of nearly all the varieties of fruits generally grown in the temperate climates, such as apples, peaches, pears, strawberries, grapes and small fruits, all of which, with proper care, bring profitable returns.

The mean elevation is 650 feet. The eastern part, for 30 to 100 miles west of the Mississippi river, is generally low and subject to inundations from numerous overflowing bayous, lakes and swamps, caused by the overflow of the Mississippi river. In this region there are a few high places, rising generally toward the table land and the high hills of the west. In the northwest part are the Ozark and Boston mountains, which, while they do not reach the height of mountains, yet are rugged, picturesque and, as compared with the country about them, are of sufficient height to justify the name. These hills or mountains continue westward into Oklahoma and northward into Missouri. Here Arkansas grows its best apples, peaches and strawberries, and these fruits have made the state famous. Nature has done much for Arkansas; but the fruit growers are not as a rule making the most of their natural advantages; for they incline to plant the trees and, without much care or the application of modern methods, permit Nature to do the rest.

The state is divided, geologically, into two parts by a line drawn from Texarkana in the southwest corner, to Miller county, running northeasterly through Little Rock, to Pawhatan in Lawrence county in the northeast. The northwestern division is hilly and underlaid with heavy paleozoic rocks, and the southeast corner with cretaceous rocks. The southeastern part is mostly alluvial soil, some of it requiring drainage, and is very fertile, therefore adapted to the growing of vegetables, strawberries and other small fruits; but cotton, corn, wheat, oats, rye, hay, potatoes and tobacco are the main crops. For further information see Ozarks.

Granville Lowther

Frost and Precipitation

Station	Frost				Precipitation
	Average Date of		Date of		Annual Inches
	1st Killing in Autumn	Last in Spring	Earliest in Autumn	Latest in Spring	
Fayetteville	Oct. 19	April 10	Sept. 29	April 30	44.3
Dodd City	Oct. 18	April 13	Sept. 29	May 1	47.2
Pocahontas	Oct. 23	April 3	Oct. 8	May 2	43.5
Fort Smith	Nov. 4	Mar. 24	Oct. 15	April 6	41.8
Conway	Oct. 27	Mar. 23	Oct. 2	April 12	45.4
Little Rock	Nov. 9	Mar. 21	Oct. 22	April 14	49.6
Helena	Nov. 1	Mar. 25	Oct. 21	April 6	55.2
Dallas	Nov. 4	April 4	Oct. 7	May 1	51.0
Pine Bluff	Nov. 6	Mar. 27	Oct. 19	April 19	48.8
Camden	Nov. 7	Mar. 24	Oct. 8	April 12	49.2
Warren	Nov. 4	Mar. 30	Oct. 10	April 8	49.0

Arizona

Arizona has an area of 113,020 square miles. In the northern part, the state is a dry plateau, arid and of little value without irrigation. In the south it is mountainous, the valleys are broad, sometimes 20 to 30 miles in width. The principal mountain masses are Castle Dome, Big Horn, Eagle Tail, Chocolate, Dome Rock, Palomas Harquahala, San Francisco and Black in the north central; Carrizo, Lukakukia and Tunica in the northeast; Zuna, White Mogollon and Catalena in the southeast and south. San Francisco mountain, above Flagstaff, is the highest, rising 12,794 feet above the sea. To the south the surface falls sharply to low ridges, mostly of volcanic origin, thence by terraced mesas down to the great desert plain little above sea level. This plain is cut by gullied stream beds in which the surface water from the occasional rainfall flows into the broad Gila valley. At Flagstaff the rainfall is 24.65 inches; at Yuma, 2.84 inches.

The sandy regions of the southwest are the hottest portions of the continent. It is common for the mercury to rise to 120 degrees Fahrenheit in the shade during July and August, but the atmosphere is so clear that, while the sun is scorching in its heat, it is said not to be oppressive, and the winter climate is excellent.

The drainage system is the Colorado river with its tributaries, the principal of which is the Gila.

There can be but little fruit grown in Arizona without irrigation. In the northern part of the state the Colorado river is the principal stream, but it runs in a deep canon, and at the present time there is no method provided that seems practical for diverting or lifting the water from this deep bed for the purposes of irrigation. The rivers of Arizona draw moisture from the mountains, but these mountains are not covered with snow during July and August, the season when the moisture is most needed for irrigating purposes. The habit of flooding the land several times during the season when the snows are melting in the mountains, then cultivating intensively during the dry season, forming a dust mulch to conserve the moisture, has been successful for the growing of certain kinds of fruits and vegetables. This system is practiced largely in many sections of the state.

The Temperature

One of the principal difficulties in growing fruit in Arizona is the extreme heat. The sun is so hot, and the air so dry, that the evaporation is very rapid, and even where there is plenty of water in the earth, the plant often fails to take it up as fast as the sun evaporates it from the leaf, and the plant withers. In order to obviate this in the growing of apples, peaches and other fruits of this character, the stem is headed very low, so that it may be shaded and the bark not be injured by the sun. Further, there is a more rapid supply of moisture where trees are headed near the ground than where they lift the water to a greater height. At Tuscon, the evaporation is said to be 78 inches per annum; which makes an abundant supply of water necessary for the growth of fruits.

The varieties of fruits best adapted to such a climate are those with thick leaves, small evaporating surface, or with few pores that admit of rapid transpiration.

From the survey of the Salt River valley, made by Thomas H. Means, we quote as follows:

Fruit Farming

"Figs are grown, but the cost of labor in handling them and the freight rates, make the industry a financial failure. The growing of stone fruits is another industry held down by the cost of labor and freight rates. Excellent fruits of this kind are grown, but the trade is largely within the state. Almonds, when they escape the late frosts, and olives, which are weighty in proportion to their value, may prove a success financially.

"Grapes are grown successfully, and the warm dry climate is eminently suited to the growing of raisins and wine grapes.

Oranges

"The orange industry of the Salt River valley is as yet in its infancy. Only a few orchards of any size are in bearing, but the success obtained by these has started a rapid development, and orange groves are rapidly being set out. The district considered most favorable for oranges lies along the base of Camelback mountain and the Phoenix mountains. Here the frost is least and the daily range of temperature the smallest. No complete losses have ever been experienced from frost, for the fruit ripens early and is off the trees before the frost comes, yet on two occasions the trees have been damaged.

"One great advantage which orange groves here have over Southern California orange groves is the date of ripening. Arizona oranges ripen in time for the Thanksgiving market and for this reason have the advantage of high prices. The larger part of the fruit is marketed by Christmas.

"The orange belt is no doubt capable of extension over a much larger area than is at present supposed to be orange territory. Great care should be given to the selection of orange lands, for there are certain areas not suited to orange culture."

Fruits Best Adapted

It would not be possible to grow commercial fruits successfully in Arizona, without carefully studying the varieties best suited to the soil and climatic conditions. In some parts the soil is adobe, some is strong in alkali and other salts, and all of it is subject to a hot sun and rapid evaporation. What varieties to choose and how to treat them under the conditions, is the problem that confronts the fruit grower.

In the New Cyclopedia of American Horticulture, J. W. Toumey gives a list of fruits and varieties that was collected as a result of 60 letters sent to the leading orchardists of the state. This list, with those recommended by the American Pomological Society* and the advice of the directors of the experiment station, will enable any one without experience to decide with considerable accuracy. The following is Mr. Toumey's list.

Almonds—Ne Plus Ultra, IXL.

Apples—Early Harvest, Early Strawberry, Red Astrachan.

Apricots, Early—Bennett's Early, Newcastle, Peach, Pringle.

Apricots, Late—Moorpark, Royal, St. Ambroise, Smith's Triumph.

Blackberries — Lawton's Early, Crandall's Early, Early Harvest.

Dewberries—May's.

Grapes—Thompson's Seedless, Sultana Seedless, Rose of Peru, Salem, Muscat, Rogers' No. 9.

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* U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 151, "Fruits Recommended for Cultivation."

Grape Fruit—Triumph, Walter, Bowin.

Lemons—Villa Franca, Sicily.

Mulberries—Downing, Russian.

Olives—Manzanillo, Nevadillo, Blanco, Mission.

Oranges—Ruby Blood, Jaffa, Parson's Brown, Mediterranean Sweet, Bahia (Washington Naval).

Peaches, Early—Early Crawford, Parson's Early, Triumph, Sneed, Strawberry.

Peaches, Late—Globe, Salway, Oldmixon, Heath's Freestone, Muir, December Cling.

Pears, Early — Brandywine, Bartlett, Wilder.

Pears, Late—Winter Nelis, Pia Berry.

Plums—Wickson, Kelsey, Botan White, Royal Native.

Pomegranates—Ruby, Sweet, Golden, Papershell.

Quinces—Champion, Portugal, Orange.

Strawberries—Arizona Everbearing.

Arizona is still an undeveloped state, and just what is possible has not yet been determined; but it seems sure that when experiments have proven the products best adapted, and the best methods have been employed, that it will be far more productive than at present.

GRANVILLE LOWTHER

Frost and Precipitation

STATION	FROST				Precipitation
	Average Date of		Date of		Annual
	First Killing in Autumn	Latest Killing in Spring	Earliest Killing in Autumn	Latest Killing in Spring	Inches
Fort Defiance	Sept. 23	June 2	Sept. 11	June 7	12.8
Mohave	Dec. 3	Feb. 23	Nov. 23	Mar. 24	5.4
Holebrook	Oct. 15	Mar. 8	Sept. 17	June 13	7.9
Signal	Nov. 15	Mar. 13	Oct. 30	April 8	7.1
Prescott	Oct. 20	Mar. 20	Sept. 15	June 2	15.6
Phoenix	Dec. 3	Feb. 23	Nov. 9	Mar. 31	6.8
Fort Apache	Oct. 13	May 10	Sept. 22	June 12	17.6
Yuma	....	....	....	....	2.7
Dudleyville	Nov. 13	Mar. 30	Oct. 16	May 3	12.0
Oracle	Dec. 4	Mar. 29	Nov. 12	May 3	15.9
Fort Grant	Nov. 26	April 1	Nov. 2	June 4	13.5
Tuscon	Nov. 22	Mar. 26	Oct. 16	May 3	9.8
Fort Huachuca	Nov. 28	April 5	Oct. 30	May 3	16.2

Artichoke

The artichoke is a thistle-like plant of the aster family, probably a native of Southern Europe, but now widely cultivated. The fleshy bases of the scales on its globular head, together with the receptacle, are edible while immature. The Jerusalem artichoke is cultivated for its edible tubers. W. R. Beattie says:

Artichoke, Globe

"Deep, rich sandy loam, with a liberal supply of well-rotted manure, is best suited for growing artichokes. Plant the seeds as soon as the soil is warm in the spring, and when the plants have formed three or four leaves they may be transplanted to rows three feet apart and two feet apart in the row. The plants do not produce until the second season, and in cold localities some form of covering will be necessary during the winter. This crop is not suited for cultivation north of the line of zero temperature.

"After the bed is once established the plants may be reset each year by using the side shoots from the base of the old plants. If not reset the bed will continue to produce for several years, but the burs will not be so large as from new plants.

The bur, or flower bud, is the part used, and the burs should be gathered before the blossom part appears. If they are removed and no seed is allowed to form, the plants will continue to produce until the end of the season.

"The heads, or burs, of the French artichoke are prepared for the table by boiling, and served with melted butter or with cream dressing.

Artichoke, Jerusalem

"The Jerusalem artichoke will grow in any good garden soil, and should be planted three to four feet apart each way, with three or four small tubers in a hill. If large tubers are used for planting they should be cut the same as Irish potatoes. Plant as soon as the ground becomes warm in the spring and cultivate as for corn. A pint of tubers cut to eyes will plant about 30 hills. The tubers will be ready for use in October, but may remain in the ground and be dug at any time during the winter.

"The tubers are prepared by boiling until soft, and are served with butter or creamed. They are also used for salads and pickles.

"The Jerusalem artichoke is not of great importance as a garden vegetable, and the plant has a tendency to become a weed."

ASHES, WOOD. See *Apple Orchard, Fertilization of.*

Asparagus

Asparagus belongs to a genus of plant containing more than 100 species. It was introduced into America from Europe and has become in this country an important article of food. Several of the climbing species are grown in greenhouses for their delicate feathery branches and are valuable for cuttings and decorations.

The young shoots of the species *Asparagus officinalis* have from very early times been much prized for food, owing to their pleasant flavor and slightly laxative properties. This species is a native of the north temperate zone of the old world, and grows wild on the south coast of England. On the waste steppes of Russia it is so abundant that it is eaten by cattle like grass.

In some sections of the country, asparagus is grown largely for the markets. It is also grown in very many private gardens for home use. It is very hardy, is a vigorous grower, and heavy feeder; therefore will succeed best on a very rich soil. It can be grown in sections strong in mineral salts, such as alkali, or in deep alluvial and peaty soils. Where the native soil is not adapted, it can be made adaptable by the digging of trenches, and filling in with barnyard manure, sand (where the soil is a heavy clay), muck, rotten leaves or other fertilizers. For commercial purposes, asparagus is planted in rows, about the width of corn rows, three to four feet apart, and the roots are planted in hills about the same distance apart, or sometimes not more than two feet apart. Some growers plant so that the stalks will row both ways, and the ground can be cultivated both lengthwise and across the field. For home use, however, it requires but few stalks and it is generally planted in trenches, or in beds.

Propagation from Seeds

Seeds should be sown in rows three to four feet apart, so as to admit of cultivation. The seeds should be planted two to four inches apart in the rows, and kept free from weeds. The time of planting is about that of any other spring crop, but may be earlier, because asparagus is not easily injured by spring frosts. These are termed nursery plants, and may be removed the following autumn or spring, and set in permanent beds, or rows, as the case may be.

Transplanting

Not all the plants grown should be transplanted to the field or bed. There is great variety of tenderness or toughness in the plants, and only the tender plants are good for food or for market. The tender plants lengthen rapidly, produce a straight succulent needle-like stem, and do not branch near the ground; while the tough plants lengthen more slowly and tend to branch near the ground. Further, the tender plants are usually straight-grained smooth and blunt at the tips. When the plants are but few inches in height it is easy to tell the difference between the tender and tough varieties. The smaller seedlings with a tendency to show woody fibre or a tough gnarled appearance should be weeded out.

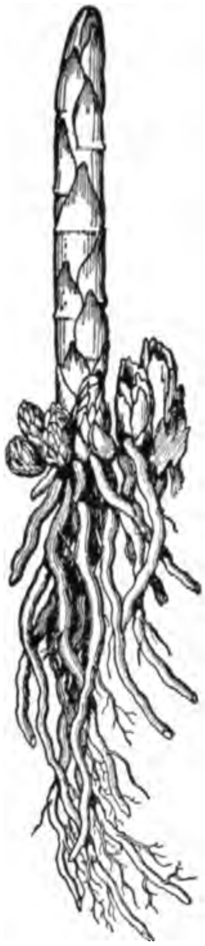

Fig. 1. Asparagus Crown, Roots, Buds and Spear. (Redrawn and reduced: from plate 113 of Thome's Flora von Deutschland.) —*Farmers Bulletin 61.*

Propagation from Roots

An asparagus plant has a very broad spreading crown, with a good many buds. Any plant which shows unusual merit in the spring when it starts into growth may have this crown divided. Often a half dozen plants may be started from the same crown. It is better to dig up the entire root, or as nearly so as it is convenient to handle; then divide the plant into sections at the joints, so that each piece possesses a few buds and some roots attached. These roots may be planted as individual plants, and when they become established will produce the same as the parent plant from which they were separated.

The roots may be set in autumn or early spring, in deep rich soil, and generally the crown should be covered from four to six inches. In a light mellow soil the depth of setting may be greater than in a heavy compact soil. They should be well cultivated, especially for the first year or two, but after they are fully established they are such vigorous growers that they are generally neglected; but even then, good cultivation pays, for it produces a larger number of vigorous, succulent young stalks for the market.

Fig. 2. Knife for Cutting Asparagus.

Cutting Asparagus

It is never best to cut plants for the table or for market until the roots have been planted two years, or, in poor soils, three years. After the age for cutting, all sprouts should be kept cut, whether they are big enough for the market or not. If the smaller stems are allowed to appear, the plant ceases to produce more sprouts. Ordinarily one may continue to cut for the market as long as the sprouts are succulent and desirable. In cutting, care should be taken not to injure the root, but cut as close to the root as possible without injury. When preparing for the markets, the sprouts should be washed in clean water, bunched and tied in neat small bundles.

Varieties

Among the best varieties are Conover's Colossal, which has very large stems, starts early in the spring and has a pronounced flavor. The Palmetto and Mammoth are sweeter, have a less pronounced flavor, and are preferred by many persons. Late in the autumn the tops should be mowed close to the ground and the field given a heavy coating of manure.

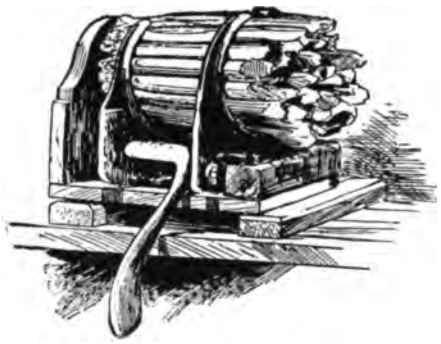

Fig. 3. Asparagus Buncher and Bunch of Spears Ready to Be Tied. —*Farmers Bulletin 61.*

Cost of an Asparagus Bed

The cost of establishing and maintaining an asparagus bed is so dependent upon the value of land, the cost of labor, the kind and amount of manure used, and the method of securing plants, etc., that no definite figures can be given, but can be best estimated by the farmer himself, remembering that it is only once in 15 or 20 years that this has to be met.

A prominent and successful New Jersey grower says:

"I cannot give the cost in detail of establishing asparagus beds, as so much would depend upon whether one had roots to buy, and upon other matters. Where growers usually grow roots for their own planting the cost is principally the labor, manure, and loss of use of land for two years, upon which, however, a half crop can be had.

"The cost of maintaining a bed I can only estimate, as at times all the men on the farm may be at work at the asparagus, and at other times none at all, and I do not keep an account of the time put in at the asparagus. I should estimate the cost per acre as follows:

Manure (applied in the spring).........	$ 25
Fertilizer (applied after cutting).......	15
Labor, plowing, cultivation, hoeing, etc.	20
Cutting and bunching................	40
Total	$100

"A bed well established, say five years after planting, when well cared for should for the next 10 or 15 years yield from 1,800 to 2,000 bunches per annum, or at 10 cents per bunch (factory price), $180 or $200."

This agrees very closely with the actual figures of the yield and receipts of another New Jersey grower who in 1896 cut 22,584 bunches from 12 acres, all of which were not in full bearing, or 1,882 bunches per acre, and received $2,611 net returns from commission houses, or a fraction over 11 cents per bunch. Of course those getting higher prices or larger yields will exceed this, but it is a fair average for those who sell on commission or to canneries.

The cost of good one-year-old plants ought not to be over $4 per thousand, and it requires from 1,800 to 3,600 to fill an acre, depending upon the distance between plants; perhaps 2,500 would be a fair number, allowing surplus plants to fill missing hills, or $10 per acre. The plants can be grown from the seed for half that sum, if that plan be preferred.

The cost of establishing a bed can be somewhat reduced by planting for the first two or three years some early garden crop between the rows, such as potatoes, peas, beets, onions, strawberries, etc., for as the roots are as yet not occupying all the ground there will be no injury to the plants, and the manure and cultivation necessary for the young asparagus will be sufficient for the other crop, hence the receipts for it will be almost entirely net, and yield at least the returns of "a half crop."

The estimate above calls for an annual expenditure of $40 per acre for fertilizer and manure, which is a liberal allowance; another estimate requires 2,000 pounds per acre of a mixture containing 400 pounds of muriate of potash, 1,100 pounds acid phosphate, and 500 pounds of nitrate of soda, which at market prices can be secured for less than the above sum.

R. B. Handy,
U. S. Dept. of Agriculture.

Asparagus

(Adapted to Southern Conditions)

This is one of the best paying crops of the garden and can be grown anywhere in the temperate regions. Any land that will grow corn will grow asparagus but it is a crop that responds readily to intensive culture. Asparagus is the first green vegetable of the spring and therefore is in great demand for home use and for market.

To prepare a permanent bed of asparagus the land should be heavily manured (at least 10 to 15 tons) and broken deeply in the fall. In early spring the land is replowed, disced both ways and thoroughly harrowed. This thorough preparation incorporates the manure with the soil.

The best time to plant asparagus in the South is in late January or early in February but in the North plantings can be made as late as November, provided the land has been thoroughly prepared some time in advance so that the manure is well decomposed.

Only strong one-year-old plants should be used, though seed can be sown in the row and the plants can be thinned out to the desired distance. Plants can be secured from any reliable seed dealer.

The distance that the plants should be set varies with different growers but for most purposes the best plan is to plant five feet between the rows and place the plants three feet apart in the row.

The land at planting time should be checked off with the plow both ways, running one way twice to make a deep furrow. The plants are set in these checks allowing a space of from 6 to 8 inches between the top of the crown and the surface of the ground. The plants should not be entirely covered with soil at the time of planting; the upper three or four inches of space will be gradually filled in by the subsequent cultivation as the plant grows through the soil.

During the first season the land should be kept well cultivated to maintain a soil mulch and also keep down weeds. Cultivation should continue until the tops have matured.

When the berries on the plants have turned red the tops should be cut down and left in the field to dry thoroughly. On a windy day the patch can be burned over thus destroying the rubbish and troublesome insects. After the patch has been burned over spread a coating of manure over it and allow this to remain as a mulch until spring.

Early in the spring of the second year the rough manure should be raked off and the ground should be worked. It is a good plan to plow furrows in both directions over the row thus leaving a ridge on the row and a dead furrow between the rows. After plowing use a spike toothed harrow or cultivator and level down the beds.

Cultivation should be given as outlined for the first season. Cut down the tops, burn over the patch and top dress with manure as before. An application of a high grade fertilizer in early summer will produce a good strong growth that forms a good root system.

The patch can be cut the third season but this cutting should be rather light. The bed should be worked as outlined for the previous seasons but early in the spring an application of from 75 to 100 pounds of nitrate of soda per acre should be made as a top dressing near the plants. This fertilizer is readily available and will give results in the crop to be cut. When cutting has ceased or about May 1st, the patch should receive an application of 1,000 pounds of fertilizer made up as follows:

Acid phosphate	400 lbs.
Nitrate of soda	100 lbs.
Cotton seed meal	350 lbs.
Muriate of potash	150 lbs.
Total	1,000 lbs.

The above is a 7-4-8 goods and it should be broadcasted and disced in running the disc across the rows. Cultivation should then be kept up as in previous years.

When cutting the asparagus select those stalks which are about 6 inches long and run the knife about 2 inches down under ground. Care must be taken in cutting not to injure the shoots which are just pushing up through the soil. Every stalk whether it is thin or fleshy should be cut at each cutting as this prevents insects from laying eggs on the old shoots that are left and it also conserves the strength of the plants. As soon as the asparagus stalks are cut they should be carried to a shady place where they are sorted and packed in bunches. These bunches are made uniform by using wooden boxes open at the top and at one end and of the desired length. The stems are then cut to an even length with the asparagus knives and the bunch is tied with raffia. These bunches usually weigh about one pound. All small, tough, withered stalks should be discarded. To keep the bunches fresh for the local market the bunches should be set upright in pans containing about an inch of water. All cutting should be done bright and early in the morning before the dew is off the plants.

The bunches are packed in crates holding two dozen bunches and the bases of the bunches are set on a layer of damp moss. The crates are made of 4 slats 3½x22 inches, 2 slats 6½x22 inches and 2 pieces 6½x9 inches, the latter for the heads.

If bleached grass is desired, hill up the rows and cut the stalks 5 inches below the surface.

If the plants are to be raised from seed a good sunny, well drained slope should be selected and the land should be prepared as for the permanent bed. Sow the seed in February and after the plants come up keep them well cultivated and fertilized. The plants are allowed to remain in the seed rows for one year and are then transplanted to the permanent bed. One ounce of seed will sow about 50 feet of drill and this will make about 200 plants.

It requires 2,900 plants for an acre, and if the plants are purchased they will cost $5.00 to $6.00 per 1,000, the cost for the acre being about $15.00.

A good patch of asparagus that has been well cared for should last 25 years and a good average yield per season should be 150 crates. If asparagus is desired very early in the spring the site for the patch should be selected on a sandy southern slope.

Varieties to be recommended are Palmetto, Conover's Colossal and Argenteuil.

W. P. Williams

ASPARAGUS DISEASES

Anthracnose

Colletotrichum sp.

Is said to have appeared in New Jersey and Ohio, but seems not to have spread destructively. It appears as small specks upon the stem.

Rust

Puccinia asparagi

Causes premature death of the bushy tops which grow up after the cutting season, thus injuring the vitality of the plants. The fungus causing the rust shows three different stages, the spring rust, appearing in the form of elliptical patches on the stems of plants which are allowed to grow up early in the season, the summer or red rust, which covers the tops with a reddish, dusty powder of spores during the summer, causing their death, and the black rust stage, which appears on the tops in the form of numerous black pustules following the red rust.

During the cutting season allow no wild asparagus to grow up.

Keep the fields well irrigated and cultivated during the summer and fall after cutting stops. Dust the tops thoroughly with flowers of sulphur about three weeks after the cutting season ends and repeat this two or three times during the remainder of the season.

Select seed for planting from the most rust-resistant plants.

Ralph E. Smith
Berkeley, Cal.

(The Palmetto variety is said to be more rust resistant than others.—Ed.)

Damping Off, Rhizoctonia, Root Rot Fungus, Stem Rot Fungus

Corticium vagum B. & C.

This fungus attacks a variety of garden plants and causes a wet rot at the surface of the ground.

The disease is difficult of control as it seems to live indefinitely in the soil.

General sanitary measures, good surface drainage and lime on acid soils is suggested.

Tendency to Variation

We give herewith an illustration of an asparagus stem, which represents the

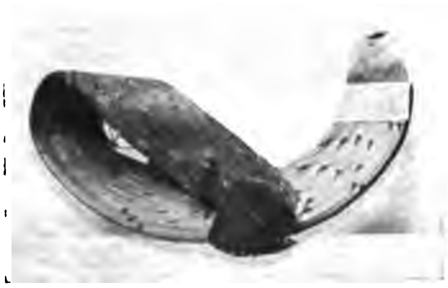

Fig. 1. Asparagus Stalk Four Feet Long, Four Inches Wide and One Inch Thick.

tendency under certain conditions, to vary from the normal. The stalk which this figure represents was about four feet long, four inches wide, and one inch thick.

ASPARAGUS PESTS

Asparagus Miner

Agromyza simplex Loew

General Appearance

The adult flies have a wing expanse of about one-sixth of an inch and are metallic-black in color. The maggots are one-fifth of an inch long and white. The puparia are one-seventh of an inch long and red.

Life History

The first adult insects appear early in the spring, other broods appearing later. The larvae mine beneath the epidermis of the stalks near the bases and may penetrate eight inches underground. The injury is often so severe as to completely girdle the stems and thus do much damage. The puparia are formed in the burrows, especially on the roots and bases of the stalks. There are at least two generations each year.

Distribution

This fly has been reported from New England to Tennessee and in California.

Food Plant

This pest works only upon asparagus plants.

Control

The control of the fly is somewhat difficult and consists in the use of trap crops early in the spring, which should be removed, roots and all, and burned in June. Other traps should be allowed to grow up immediately and similarly destroyed in the fall.

Cutting out all infested stalks as often as they appear is also advisable.

E. O. Essig

Common Asparagus Beetle

Crioceris asparagi Linn.

General Appearance

The adult beetles are slightly less than one-fourth of an inch in length and very slender. The color is metallic bluish-black with red thorax marked with black dots. The reddish-yellow or cream colored wing covers are marked with black. The eggs are elongate, about one-tenth of an inch long, dark brown or black and stuck to the shoots by one end. The larvae are shiny olive gray with black head and legs. The pupal stage is passed in the ground in a thin cocoon, the pupae being yellowish in color.

Life History

The adults hibernate during the winter under any protective covering and appear in the spring about the time the young asparagus shoots are coming through the ground. The adults immediately begin to feed upon the tender sprouts and to lay their eggs upon them. The eggs hatch in about a week and the grubs begin to feed upon the sprouts. The broods continue to work throughout the summer eating all parts of the asparagus plants. After about two weeks the larvae are ready to pupate. They then leave the plant and work into the soil where pupation takes place and within eight or nine days they emerge as adults. The entire life cycle requires one month but there are many overlapping generations each year.

Distribution

New England, south and west to the Mississippi, and in California.

Food Plant

So far as known, the pest feeds only upon asparagus, attacking principally the tender shoots but also working upon the rind and stems of the older seed plants.

Control

The control of this pest is not so difficult as it would seem in view of the fact that arsenical sprays cannot be used upon the tender marketable shoots because of the poisonous effects to the consumers.

In the spring when harvesting the shoots it is advisable to leave some of them for the beetles to lay their eggs upon; cutting and burning these before the eggs hatch. Another practice is to keep all the seedlings except a few for traps, cut down. Upon those left the beetles will collect in great numbers and may be easily killed. In the spring or after they are covered with eggs the plants should be cut down and burned.

As soon as the crop is harvested the seedlings and feathery plants should be thoroughly sprayed with arsenical sprays, which will serve to kill many of the mature beetles before they go into winter quarters. One pound of lead arsenate to sixteen gallons of water has given excellent results.

Dusting air-slacked lime of pyrethrum upon the larvae or spraying plants infested by them with kerosene emulsion or tobacco extract are exceedingly effective as the larvae are very delicate. Brushing to the ground also destroys large numbers of them. Burning the rubbish in the winter destroys many of the hibernating beetles.

Natural Enemies

The young of the ladybird beetles, *Megilla maculata* and *Hippodamia convergens*, prey upon the young larvae. In the east the spined soldier-bug (*Podisus maculiventris* Say) and the bordered soldier-bug (*Stiretrus anchorago* Fab.) as well as certain other insects also feed upon the larvae.

E. O. Essig

Twelve-Spotted Asparagus Beetle

Orioceris 12-punctata L.

Description

A trifle larger and stouter than the common species, uniformly reddish in color, with 12 black spots on the wing covers. Eggs are attached by their sides instead of ends, usually on old plants instead of young shoots if such are available.

Character of Injury

Hibernated beetles feed on shoots in spring. Later beetles and larvae prefer the berries. Larvae seem to feed almost exclusively on the berries. Cut all plants down to the ground in early spring, and cut new shoots before eggs hatch. Allow some shoots scattered over the field to grow larger than others and most of the eggs will be deposited on these. When they are well covered with eggs cut and burn and allow other shoots to grow for same purpose. Spray with arsenate of lead late in the season when cutting period is over. Chickens and ducks will devour many if given the run of the garden.

H. A. Gossard,
Wooster, Ohio.

Australia

Orchards and Fruit Gardens

Fruit growing has made rapid progress in Australia during recent years, the area devoted thereto having increased in the past ten years by no less than 56,936 acres. The states in which the increase was most marked were: Tasmania, 17,900 acres; Victoria, 12,731 acres; Western Australia, 12,668 acres; and South Australia, 6,529 acres. During the same period the Queensland fruit-growing area increased 5,738 acres, while in New South Wales a slight increase of 1,310 acres was exhibited.

The varieties of fruit grown differ materially in various parts of the several states, and range between such fruits as the pineapple, paw-paw, mango, and guava of the tropics, and the strawberry, the raspberry, and the currant of the colder parts of the temperate zone. The principal varieties grown in Victoria are the apple, pear, peach, apricot, plum, and cherry. In New South Wales citrus fruits (orange, lemon, etc.) occupy the leading positions, although apples, pears, peaches, cherries, plums, and apricots are also extensively grown. In Queensland the bananas, oranges, pineapples, peaches, apples, mangoes, and plums are most largely grown. In South Australia, in addition to the apple, pear, peach, apricot, plum, orange and lemon, the almond and the olive are also largely grown. In Western Australia, the apple, orange, peach, pear, plum and fig are the sorts chiefly grown, while in Tasmania, although the apple represents four-fifths of the area in that state devoted to fruit growing, small fruits, such as the currant, raspberry, and gooseberry, are very extensively grown, and the balance of the area is mainly occupied with the pear, plum, apricot, peach and cherry.

Area Under Fruit in the Commonwealth, Year Ending March 31st, 1913

	N. S. W.	Victoria	Queensland	S. A.	W. A.	Tasmania	C'wealth
Fruits	49,389	63,209	18,556	29,905	19,540	30,575	205,174
Vines—Wine	8,103	24,579	1,428	25,208	3,010	....	62,388
Vines—Table	3,893	2,624	1,046	2,194	1,891	....	11,648
Market gardens	9,836	10,414	2,386	2,857	3,664	1,458	30,676
Melons	4,174	2,682	6,122	....	731	....	13,662
Hops	....	131	....	5	....	1,247	1,383
Acres	75,455	108,589	29,538	60,169	28,836	33,280	324,981

Value of Fruit (English Pounds) in the Commonwealth, Year Ending March 31, 1913

	N. S. W.	Victoria	Queensland	S. A.	W. A.	Tasmania	C'wealth
Fruits (not including vines)	832,472	880,657	365,177	393,433	210,531	384,877	3,067,147
Hops	....	10,421	....	100	....	104,031	114,552
Pumpkins, melons	74,805	25,000	61,758	....	5,751	....	167,354
Market gardens	369,069	286,385	64,265	106,736	121,874	12,295	962,535
	1,276,346	1,202,463	491,200	500,269	338,156	501,203	4,311,588

Raisins and Currants Dried 1912-1913

Victoria, 12,283,824 acres; New South Wales, 494,704 acres; South Australia, 3,947,776; Western Australia, 176,400 acres.

For the statistical year ending March 31, 1913, there were in the jam manufacturing business 133 factories working in the Commonwealth; total number of employees was 4,499; the wages paid amounted to £275,138. The total value of the output reached £1,884,045, and the amount of material used was £1,276,180.—From the *Fruit World*, March 1, 1914.

BABYLONIA, IRRIGATION IN. See *Irrigation.*

Bacteria

The subject of bacteria is treated here only so far as is necessary to give the reader some facts which will enable him to understand the references to the subject which are made in other parts of the work.

These minute organisms are sometimes called microbes, micro-organisms, microphytes, bacilli, micrococci, etc. All of these terms are more or less limited in their meaning and the term "bacteria" is the one in most common use.

Early in the history of the subject these minute organisms, of which there are now known perhaps a quarter of a million species, were called by the general name of *animalculae.* The term implies what was believed to be the case that these organisms were animals, but the classification was later discovered to include plants as well as animals. In the unicellular forms it is often impossible to determine which is animal and which plant and in this discussion it is not important to do so. In general, bacteria are defined as minute organisms, devoid of chlorophyl, unicellular, spherical, oblong, cylindrical or filamentous, and multiplying by division.

Distribution

Bacteria exist practically everywhere; in ponds, ditches, streams, seas, refuse, meat, milk, beer, fruits, vegetables, soils, and enter into all putrifactive processes.

Nitrifying Bacteria

The bacteria in which the farmer is most interested are the various soil bacteria and the nitrifying or nitrogen gathering bacteria in particular. It has been discovered that certain forms of bacteria are capable of fixing free nitrogen. These are found most often on the leguminous plants where they collect in nodules. The physical action of these colonies is to break up the organic matter in the soil and, through the action of certain acid by-products, the inorganic as well. They thus render soluble the various elements in the soil which are necessary for plant food. In addition they seem capable of utilizing free nitrogen from the air in such a way as to increase the quantity of this element in the soil. Thus the nitrogenous or leguminous plants such as clover, vetch, alfalfa, beans, peas, etc., tend to improve the quality of a soil which is in need of nitrogen.

Prof. H. Marshall Ward, University of Cambridge, says:

"These bacteria can build up organic matter from purely mineral sources by assimilating carbon from carbon-dioxide in the dark, and by obtaining their nitrogen from ammonia. The energy liberated during the oxidation of the nitrogen is regarded as splitting the carbon-dioxide molecule—in green plants, this work is done by the solar rays. Since the supply of free oxygen is dependent on the activity of green plants, the process is indirectly dependent on energy derived from the sun, but it is nevertheless an astounding process and outside the limits of our previous generalizations."

Important results often occur, in the fact that these bacteria tend to disintegrate stone, rot sand particles, rust iron and copper, rendering their particles soluble.

Saprophytic and Parasitic Bacteria

Saprophytic bacteria are those which live in dead matter whether animal or vegetable. They are associated with most decomposing processes.

Prof. A. C. Abbott, of the University of Pennsylvania, says:

"The saprophytic group comprehends many species used in the fine arts and industries—such for instance as those concerned in the production of certain organic acids; those employed in the manufacture of indigo by the fermentation process and in the preparation of hemp; and in those used in the manufacture of cheese and butter. In the study of this large group, one constantly encounters other species presenting most engaging characteristics. Some of these varieties have the property of producing, during the course of their growth, pigments of great beauty—brilliant reds, delicate pinks, rich purples, yellows ranging from the palest lemon to the deepest orange. In another group, we meet with species having the emission of light as their most singular peculiarity. When growing, these forms glow with a peculiar phosphorescence, and it is significant to note that these luminous varieties have been most frequently encountered in the sea, and upon articles from the sea. The evil odors of putrefaction are the results of saprophytic bacterial development.

"In the *parasitic* group of bacteria, we encounter those species that exist always at the expense of a living host, either animal or vegetable, and in doing so not only appropriate materials necessary to life, but give off in return waste products that may act as direct poisons to the host. Fortunately this is a much smaller group than the saprophytic. In no particulars, save for their ability to exist at the expense of a living host and cause disease, are the disease producing bacteria distinguishable from the innocent varieties. The essential difference between the disease producing and the innocent bacteria, is that the former possess as their most striking physiological peculiarity, the power of elaborating toxins or poisons, that have a direct effect, or destructive action upon the tissue of their host."

H. Marshall Ward says: "A long list of plant diseases has of late years been attributed to bacterial action. Some, *e. g.* the Sereh disease of the sugar cane, the slime fluxes in oaks and other trees, are not only very doubtful cases, in which yeast and other organisms such as fungi play their parts, but it may be regarded as extremely improbable that the bacteria are the primary agents at all. They are doubtless saprophytic forms, that have gained access to rotting tissues, injured by other agents.

"Saprophytic bacteria can readily make their way down the dead hyph (branch) of an invading fungus, or into the punctures made by insects, and aphides have been accredited with the bacterial infection of carnations, though more recent researches by Woods go to show the correctness of his conclusions that aphides alone are responsible for the carnation disease. On the other hand, recent investigations have brought to light cases in which bacteria are certainly the primary agents in the diseases of plants. The principal features are the stoppage of the vessels, and the consequent wilting of the shoots; as a rule, the cut vessels on the transverse sections of the shoots appear brown and choked with a dark yellowish slime in which bacteria may be detected; examples in cabbages, cucumbers and potatoes."

A familiar example is that of the common blight of apple and pear. See article on this subject under *Pear.*

Prof. Ward observes further:

"In the carnation disease and in certain diseases of tobacco and other plants the seat of bacterial action appears to be the parenchyma, and it may be that aphides and other piercing insects infect the plants, much as insects convey pollen from plant to plant, or (though in a different way) as mosquitoes infect man with malaria. If the recent work on cabbage diseases may be accepted, the bacteria make their entry at the water pores at the margins of the leaf, and thence by way of the glandular cells of the tracheids. Little is known of the mode of action of bacteria on these plants, but it may be assumed with great confidence that they excrete enzymes and poisons, (toxins) which diffuse into the cells and kill them, and that the effects are in principle the same as those of parasitic fungi. Support is found for this opinion in Beyerinck's discovery that the juices of tobacco plants affected with a disease known as 'leaf mosaic,' will induce this disease after filtration through porcelain."

Method of Study and Discovery

How to discover the specific cause of any disease, is a question of the greatest importance. This is done generally by three steps:

First. The discovery of disease in the affected tissues.

Second. Obtaining the bacterium of this disease, in pure culture.

Third. The production of the disease, by inoculation, with a pure culture.

By means of microscopic examination more than one organism may sometimes be observed in the tissues, but one single organism by its constant presence and special relation to tissue changes, can usually be selected as the probable cause of the disease, and attempts towards its cultivation can then be made.

In cultivating bacteria, outside the body from which it is originally taken, the food material in which it is cultivated, must first of all be sterilized by heat. This food material should be as nearly like that of the body from which it is taken, as possible. The media are used either in a fluid or solid condition, and are placed in glass tubes or flasks plugged with cotton-wool.

Inoculation

In testing the effects of bacteria by inoculation, young and vigorous cultures must be used, and in the case of plants, injected into the sap at some point where the cells are vigorous, or in the case of animals, by means of a hypodermic syringe into the subcutaneous tissue into the vein, into one of the serus sacs, or more rarely into some special part of the body.

Immunity

By immunity from disease, we mean, non-susceptibility; or not being susceptible by means of infection, contagion or inoculation. The entrance of a bacterium or any number of bacteria into the tissues, does not mean disease, necessarily. Even though the bacteria be virulent or poisonous, the plant or the person may have resisting power sufficient to neutralize its effects. With regard to diseases in persons, it has been shown that certain races are practically immune from certain diseases, as in the case of the Negro in relation to malarial diseases.

In certain physical conditions, persons and plants are more susceptible than others, as in the case of fatigue, starvation, exposure to cold and whatever would tend to lower the vitality. This has been observed to be true in plants as well as in animals. A tree that is not properly nourished, is susceptible to many forms of disease, to which the healthy tree is immune. On this general subject, Professor Muir, of the University of Glasgow, says:

"In this way conditions formerly believed to be the causes of disease, are now recognized as playing their part in predisposing to the action of the true causal agent, viz.: the bacterium. In health the blood and internal tissues, are bacterium free; after death, they offer a most suitable pabulum for various bacteria; but between these two extreme states are conditions of varying liability to infection. It is also probable that in a state of health, organisms do gain entrance to the blood from time to time and are rapidly killed off. Immunity is generally spoken of under three distinct heads:

"First. Natural immunity.

"Second. Active immunity.

"Third. Passive immunity.

"Natural immunity may depend upon lack of sensitiveness to the bacteria or its toxins; as in the case of pear blight, which might enter the tips of the branches or the flowers, but could not enter where the bark is thick, unless injected by some insect or instrument.

"Active immunity is illustrated in the case of persons who after recovering from an attack of certain infective disease, such as smallpox, are not susceptible to subsequent attacks. Or, it may be illustrated again, by persons who have been inoculated with bacteria, that produce a modified attack of the disease as a prevention from attack in its more virulent form. Sometimes the injections are small at first, and are increased from time to time, and in this manner persons have been rendered free from snakes, scorpions and certain vegetable toxins. It is noted that the stings of bees, which to some persons are very poisonous, are not so to the same persons, after having been stung a number of times.

"Passive immunity is secured by giving anti-toxins or anti-sera."

GRANVILLE LOWTHER

BALANCED SOILS. See *Soil.*

Banana

The fruit of the banana plant ***Musa sapientum*** grows in clusters of large finger-like forms, upon a very large spike or stem, containing, within a red or yellow rind, a nutritious pulp. This pulp is usually seedless and constitutes an important article of food. In some of the islands of the Pacific, it is a staple article of diet for the natives.

Scientists have recognized and classified as many as 40 different species, ranging from the ornamental groups that do not develop fruit, to the giant bananas, the *Platano* of the Spaniards.

The red banana is not common in the American markets. "There is a reason." In the United States it is used only to "dress" fancy baskets of fruit, but in the tropical countries it is quite a favorite. The individual banana is large, but the stalk does not carry as many "hands" as the yellow varieties, so as it does not bring as large a price to the grower and wholesaler, its extensive cultivation is not encouraged.

Banana culture is one of the oldest of industries. It has been known since the origin of the human race. Long before the dawn of history in the Old World, perhaps long before the Old World rose from the waters, man lived on the fruit of the ***Musas***. The banana was generally considered a native of Southern Asia and to have been carried into America by Europeans, until Humboldt threw doubt upon its purely Asiatic origin, quoting early authors who asserted that the banana was cultivated in America long before the Conquest. It is claimed that at the time of the Incas in Peru, bananas formed one of the staple foods of the natives of the warm and temperate regions of the Montana. In spite of the uncertainty as to just which country may claim the fruit as indigenous, all tropical lands assert their right to it.

The first importation of bananas to the United States occurred in 1804, when the schooner Reynard, on a voyage from Cuba, brought into New York, as a commercial venture, a consignment of 30 bunches; but the real beginning of the trade dates back to 1866, when Mr. Charles Frank undertook the importation of fruit from Colon to New York. Previous to that venture small cargoes consisting mainly of the red banana had been received at irregular intervals from Cuba. In 1870, Captain Baker, an owner of a Cape Cod schooner, took a charter to carry gold miners and machinery 300 miles up to Orinoco river in Venezuela. After discharging his cargo, Captain Baker ran into Jamaica to secure some cocoanuts as ballast to New York, carrying a few bunches of bananas on the deck as an experiment. The result promised a great future for the industry on that island, which has been fulfilled, the exports last year reaching $4,000,000.

On the American continent, bananas are successfully grown through 50 degrees of latitude, from Tampico, Mexico, 25 degrees north, to Asuncion in Paraguay, in the Tropic of Capricorn, 25 degrees south—a belt over 3,000 miles in width. Cultivation of the fruit is practically restricted to the eastern coast line, for the banana is one of the thirstiest of plants, and can not be expected to produce its maximum amount of fruit in districts where there are less than 100 inches of annual rainfall. Unfortunately for humanity, great areas of the land lying within this belt are high, dry, and sterile, while others are sandy or rocky, so only a small fraction is so located that banana growing can be made profitable. The altitude must not invite danger of frost, and high temperature is necessary for the growth. The southern coast of the Mexican Gulf, the Puerto Barrios section of Gautemala, the Puerto Cortes district of Honduras, the Puerto Limon district of Costa Rica, the Bluefields district of Nicaragua, the Bocas del Torro region of Panama, the Colombian province of Santa Marta, and certain portions of Cuba, Jamaica, the Dominican Republic, Haiti, and Dutch Guiana, all combine the favored elements of soil and climate.

The plant has two natural enemies—the gopher and the wind storm—but against almost all other tropical conditions its hardihood is remarkable. It is practically immune from insect pests, and a worm-eaten banana or the stalk of a bunch practically destroyed by any of the boring insects of the tropics is unknown. The damage from high winds can be avoided or minimized either by planting in locations protected from storms or by leaving unfelled strips of native forest as protective screens. Where the gopher interferes, it can be fought by the use of carbon bisulphite. There is, however, a "witch broom" disease which has affected the Gros Michel variety in Dutch Guiana, and a "Panama" sickness which has attacked certain other varieties.

It is a matter of common observation that the banana is absolutely seedless, cultivation through innumerable generations having led to a vegetable method of propagation. Some of the primitive seed-bearing varieties are still said to exist in isolated regions of the Far East.

Clearing the Land

The first step toward cultivation is the clearing of the land. Into the tangle of shrubs and vines and the thick snarl of tropical vegetation the laborer comes with an ax and "machete" and cuts low everything but the giant trees. When all of the small timber and brush has been felled planting is commenced.

Planting

Young shoots are obtained from a plantation already in bearing, and these are placed in rows about 12 feet apart. When the planting is finished, the only labor necessary is to keep down the weeds and carefully clean the ground about the root of each stalk.

Growth

The banana plant will grow with wonderful rapidity under favorable circumstances. In fact, the development from a newly-planted sucker to the plant in full bearing is simply short of marvelous. Within a space of six or seven weeks the 2 or 3 foot plant has more than doubled in size, and a month or so later the leaves cease to unfold and a spike appears out of the center of the crown. This is the future stalk of the bunch and carries a huge red blossom at the end. It develops rapidly, continually bending more and more until in a short time it has turned completely upon itself, so that the bananas grow end up or in a position the reverse of which they are usually hung. From 7 to 12 months after the blossom appears the fruit is ready for the gatherer. At irregular intervals along the entire stalk, and only extending part of the way round at any one place, the bracts break forth tiny ridges of flowers—which are almost immediately replaced by 9 to 12 embryo bananas. These are the future "hands" of the bunch, so called on account of their resemblance to those members when held in a certain position.

It is by means of these hands that the fruit is classified for shipping. A bunch of 9 hands or over (the average being 10 to 12) constitute a "first;" between 7 and 9, a "second." Anything under this minimum is discarded by an inspector at the wharf. Bunches of 17 hands are exceptional, and those of this abnormal size are usually not shipped, owing to the inconvenience of storing in the steamer's hold.

Propagation

The banana has a curious and prodigal method of propagation, for before the parent stalk and fruit have matured new ones spring up. These are offshoots that grow from the root of the original planting, resembling the sprouts from the "eyes" of a potato, and each in turn becomes a parent stalk with its fruit. It follows that unless most of the continually appearing new plants are cut out (which is the practice) the first stalk in a few years will become the center of a miniature jungle. The plants grow to a height of from 15 to 35 feet, spreading in all directions, until the soil is overburdened with an enormous mass of stalk and leaf growth, and stunted fruit is produced.

In cultivation, four suckers (which is another name for the shoots) are usually allowed to grow in one hill, and their graduation is so arranged that while the oldest is bearing fruit the next is in blossom, the third is half grown, and the last is just coming forth from the ground. The banana plantation yields a continuous harvest for years without replanting. Some that are fifty years old are yielding today as prolifically as in their third or fourth year, but these are located in exceptionally fertile districts. The rotation of crops is unknown, and unless the land is subject to overflow it can hardly be profitable after ten years' working.

Planting

In planting for the market about 200 hills are allowed to the acre. Sometimes the number can be safely increased to 225, in which case there will be 900 stalks. However, after one year all of these stalks do not produce a marketable bunch of bananas, and the average yield is not over 300 full bunches to the acre per annum.

FRANKLIN ADAMS,
Pan-American Union.

Banana Flour

During the past two or three years many popular statements have appeared concerning banana flour or meal. Little reliable information, however, has apparently been available on this subject. Banana flour is prepared by cutting the fruit into suitable pieces, drying, and grinding. Several years ago the Royal Gardens, Kew (England), published a somewhat extended discussion of the food value of bananas and banana flour and stated that the latter article, according to the testimony of travelers, had been prepared by native inhabitants of tropical countries since early times. The Connecticut State Station recently published analyses of banana flour made from three sorts of bananas. In the following table the composition of these samples is shown. For purposes of comparison, the composition of fresh bananas, wheat flour, rice, and fresh and dried apples is also included.

Composition of Banana Flour and Other Foods

	Water	Protein	Fat	Carbohydrates	Fiber	Ash
Banana flour:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
From Porto Rico fruit	13.43	3.50	0.47	79.82	0.54	2.24
From Florida fruit	5.34	2.81	.66	87.45	.84	2.90
From Honduras fruit	10.33	2.87	.50	87.02	.73	2.55
Bananas, fresh, edible portion	75.30	1.30	.60	21.00	1.00	.80
Apples, fresh, edible portion	84.60	.40	.50	18.00	1.20	.30
Apples, dried	28.10	1.60	2.20	66.10	....	2.00
Wheat flour, patent roller process	11.50	11.40	1.00	75.40	.20	.50
Rice	12.30	8.00	.30	78.80	.20	.40

Dried ground bananas are seen to contain in the same bulk more nutritive material than the fresh. This would naturally be the case, since a large part of the water in them was removed in drying. Fresh bananas and apples are somewhat similar in chemical composition and the same is true of the dried products. The dried apples contain somewhat more water and hence less nutritive material than the dried and ground bananas. Banana flour contains much less protein than wheat flour.

As pointed out by the Connecticut State Station, the three samples of banana flour analyzed are quite alike in composition. They contain less than half as much protein as rice. Their nutritive value rests almost wholly in the materials which constitute nitrogen-free extract. In those countries where banana flour is prepared in considerable quantity, it is used in combination with milk, sugar, etc., in the preparation of custards, cakes and similar articles.

C. F. Langworthy

Imports of Bananas—Years Ending June 30, 1909-1913

Imported from	1909	1910	1911	1912	1913
		BANANAS (Free)			
North America:	Bunches	Bunches	Bunches	Bunches	Bunches
British Honduras	413,300	416,218	549,060	557,160	651,064
Canada	3,918	2,047	9,626	10,299	4,398
Central American States—					
Costa Rica	5,912,200	8,193,800	7,887,700	7,053,664	6,973,684
Guatemala	658,300	755,600	1,458,500	2,017,650	2,359,250
Honduras	5,624,807	5,364,831	6,901,895	7,151,178	7,983,591
Nicaragua	1,171,800	1,286,581	2,139,732	2,270,100	1,681,944
Panama	3,772,561	3,402,500	4,043,000	4,581,500	4,438,300
Salvador	....	....	....	352	....
Mexico	212,214	241,824	584,842	817,006	1,541,504
West Indies—					
British—					
Barbados	14,705,454	14,380,498	....	....	....
Jamaica			15,322,867	15,467,918	11,168,269
Trin. and Tobago			....	....	....
Other British			636	6,595	1,625
Cuba	2,407,918	2,223,210	2,670,200	2,478,581	2,213,733
Dutch	....	....	17,000	....	....
Santo Domingo	140,000	218,000	509,308	304,000	475,500
South America:					
Brazil	50,481	....	....	....	....
Colombia	1,492,692	1,012,564	2,540,583	1,542,988	2,684,749
Guiana—Dutch	407,939	659,486	564,273	261,548	184,498
Total	36,973,584	38,156,659	44,699,222	44,520,539	42,357,109
RECAPITULATION.					
North America	35,022,472	36,484,609	41,594,366	42,716,003	39,487,862
South America	1,951,112	1,672,050	3,104,856	1,804,536	2,869,247

Imports of Bananas—Years Ending June 30, 1909-1913—Continued

Imported from	1909 Dollars	1910 Dollars	1911 Dollars	1912 Dollars	1913 Dollars
North America:					
British Honduras	101,930	101,741	137,495	130,703	163,249
Canada	5,316	2,048	7,660	6,936	4,111
Central American States—					
Costa Rica	2,186,545	3,031,556	2,785,758	2,713,532	2,744,813
Guatemala	168,825	192,363	363,690	509,017	600,041
Honduras	1,731,515	1,524,848	2,039,472	2,199,890	2,435,006
Nicaragua	207,961	222,858	395,612	415,389	348,064
Panama	958,117	918,331	1,784,495	2,137,890	2,082,502
Salvador	....	....	....	88	....
Mexico	35,180	52,507	116,700	226,836	413,315
West Indies—					
British—					
Barbados	4,153,139	4,240,343	....	....	....
Jamaica			4,564,680	4,403,341	3,488,498
Trin. and Tobago			....	....	....
Other British			117	1,893	466
Cuba	891,773	841,327	897,314	942,481	834,206
Dutch	....	....	5,100	....	....
Santo Domingo	70,000	109,000	252,928	152,003	222,626
South America:					
Brazil	12,538	....	....	....	....
Colombia	362,248	243,905	887,928	453,271	1,107,429
Guiana—Dutch	127,013	161,871	136,126	66,060	39,932
Total	11,012,100	11,642,693	14,375,075	14,368,330	14,484,258
RECAPITULATION.					
North America	10,510,301	11,236,917	13,351,021	13,848,999	13,336,897
South America	501,799	405,776	1,024,054	519,331	1,147,361

World Production and Consumption of Bananas

A report upon the world production and consumption of bananas, from Consul Julius D. Dreher, Port Antonio, Jamaica, was published in the Daily Consular and Trade Reports of December 26, 1912. According to this report Jamaica was far ahead of all other countries in the exportation of bananas during the calendar year 1911, having shipped a total of 16,497,385 bunches, valued by colonial officials at $7,088,451, or more than one-half of the total value of all exports from the island in that year. Costa Rica ranked second, with exports of 9,309,586 bunches, and then came Honduras with 6,500,000 bunches, Colombia, 4,901,894; Panama, 4,261,500; Canary Islands, 2,648,378; Cuba, 2,500,000; Nicaragua, 2,250,000; Gautemala, 1,755,704; Mexico, 750,000; British Honduras, 525,000; Santo Domingo, 400,000; Dutch Guiana, 387,516, and other countries, 250,000, making a grand total of 52,936,963 bunches of bananas exported. It should be borne in mind that the world's actual production of bananas is far greater than the amount exported, since there are many isolated regions, like the numerous island groups of the Pacific ocean, that have no foreign market for their abundant crops of this fruit, and in the countries which export bananas the home consumption is enormous. In Jamaica, as in other countries, the natives not only eat ripe bananas as a fruit, but they boil the green fruit and eat it as a vegetable and also use it in this form to fatten pigs.

As Jamaica is officially reported as having had 82,436 acres in bananas last year, when the exports amounted to 16,497,385 bunches, it appears that the average number of exportable bunches produced per acre was 200; and as the average market price as shown by American consular invoices issued to shippers was 27½ cents a bunch, the average gross yield for the island was $55 an acre. In Panama and Costa Rica, where the land is very fertile and the plants are set farther apart, the average exportable crop is 140 to 150 bunches an acre; in Colombia it is nearly 200.

While Jamaica exported nearly twice as many bananas last year as any other country, the United States imported more than five times as many as any other country. For the fiscal year ended June 30, 1912, the bananas imported into the United States reached the enormous total of 44,520,539 bunches, valued at $14,368,330, an average of 32.3 cents a bunch, as the market value shown in America consular invoices certified at the shipping ports. Great Britain imported during the calendar year 1911 a total of 6,714,479 bunches, value $8,943,099, an average of $1.33 a bunch, the value fixed at the importing ports. During the same year the value of bananas (including banana food products) imported into Germany amounted to $1,974,046. It should be stated that some of the bananas imported into Great Britain are sent to Germany and other countries of Northern Europe, and that Hamburg, which is a great distributing center, ships bananas arriving at that port to Scandinavia and elsewhere. France and other countries of Southern Europe receive very few bananas.

The banana supply of the United States was received from the following countries: Jamaica, 15,467,918 bunches; Honduras, 7,151,178; Costa Rica, 7,053,664; Panama, 4,581,500; Cuba, 2,478,581; Nicaragua, 2,270,100; Gautemala, 2,017,650; Colombia, 1,542,988; Mexico, 817,006; British Honduras, 557,160; Dominican Republic, 304,000; Dutch Guiana, 261,548; and other countries, 17,246 bunches. Estimating the average number of bananas at 140 to the bunch, it appears that the people of the United States consume over 6,000,000,000 bananas a year, or more than 5 dozen for every man, woman, and child in the United States, including Alaska and Hawaii.

The increasing consumption of bananas in a number of countries naturally raises the question of an adequate supply to meet the coming demand. In Jamaica, where the immense banana crop is produced on about 3 per cent of the total acreage of the island, there is yet plenty of suitable land available. In Mexico, Central America, Panama and Colombia, not to mention the large possibilities of Haiti and the Dominican Republic, there are vast tracts of land where a fertile soil, a warm climate, and abundant rainfall favor the production of bananas on a large scale. Not only is there land enough, but the profits of the crop are sufficiently remunerative to attract the investment of ample capital to meet the world's demand.

Beam Tree. See *Apple, Botany of.*

Beans

The bean is one of the most widely cultivated of garden plants, and includes several varieties, among which are the following: Bunch bean, kidney bean, pole bean, string bean, butter bean, lima bean, haricot bean, French bean, and Carolina bean.

The following are not in common use, but are of historical interest. Carob bean, the fruit of the carob tree that grew in Palestine, the pod of which had a sweetish taste; same as locust tree.

Buck bean, a bog herb of the gentian family.

Brazilian bean, the fruit of a tree of the laurel family.

Calabar bean, the highly poisonous seed of an African climber. It is used chiefly for contracting the pupil of the eye, occasionally for tetanus, epilepsy and other nervous disorders. With the natives of old Calabar, it was a test for crime, witchcraft, etc., whence it came to be called the ordeal bean.

Egyptian, Pythagorean, or sacred bean, the fruit of the lotus.

Florida bean, the fruit of a West India, leguminous climber often washed up on the coast of Florida.

Sea bean, the fruit of a climbing shrub growing in tropical America.

Goa bean, the edible seed of an Indian plant.

St. Ignatius bean, the seeds of the logania family which yield strychnin.

Indian bean, the catalpa.

Scarlet bean or Spanish bean, cultivated for its scarlet flowers.

Tonqua bean, the fragrant seed of a large tree of the bean family.

The bean, usually cultivated for its food, is an annual, and is horticulturally divided into bush and pole varieties. Under the bush varieties, may be included all those that have stout, erect, or slightly twining stem. Under pole varieties are included those that have twining stems, and are benefited by having some kind of support, around which they may entwine. Certain varieties are often planted with corn, entwining around the stalk, and are familiarly known as "corn beans."

Navy Bean

The navy bean is a small white bean generally sown in drills about 18 inches apart between the drills, and about two to four inches apart in the row. This gives room for cultivation with a small plow. Sometimes they are sown broadcast, gathered in the autumn and threshed like wheat or oats. Sometimes the threshing is done with a flail, or by treading with horses.

Bunch Beans or Bush Beans

Bunch beans are planted in the garden, generally for home use, or for sale while green in the form known as "string beans." Included in the varieties of bush beans are White Marrow, Burlinghame, Medium and Snow Flake.

Lima Beans

Among the varieties of Lima beans, are the dwarf Lima and the pole Limas. The dwarf varieties are growing into favor, because they require less work than the pole Limas. If the pole varieties are planted, as soon as the beans begin to vine, poles six to eight feet long should be set, one for each hill of beans, and the vines allowed to entwine about them.

The Soil

Unlike most other vegetables, the bean does not require a rich soil. If the soil is rich, it produces heavy vines, and not a heavy crop of beans. It is possible therefore, to grow beans successfully on soil too poor for ordinary crops. The bean is also a leguminous vegetable, gathering nitrogen and improving the soil conditions.

Varieties

Improved Prolific Black Wax, Extra Early Refugee, Bismark Black Wax Prolific, Dwarf Horticultural, Stringless Green Pod, Early Warwick.

GRANVILLE LOWTHER

Bean Growing in Eastern Washington and Oregon, and Northern Idaho

LEE W. FLUHARTY,
Assistant Agriculturist,
Office of Farm Management

The arable land of Eastern Washington, Eastern Oregon, and Northern Idaho has been devoted almost exclusively to the production of wheat, oats, and barley for more than 30 years.

While wheat, oats, and barley are the crops most universally grown, a small portion of the wheat belt of Washington, Oregon, and Idaho is well adapted to the production of beans. The area best suited to this crop lies along the foothills of the Blue mountains in Umatilla county, Oregon, Walla Walla, Columbia, Garfield, and Asotin counties, Washington, and along the foothills of the Craig mountains and adjacent to the canyons of the Clearwater and Potlatch rivers in Nez Perce, Lewis, and Latah counties, Idaho. A few districts are in Whitman, Spokane and Stevens counties, Washington, where the climatic conditions are favorable for bean culture. While it is true that only a limited area is adapted to this crop a careful study of all the details of its production shows that thousands of acres now lying idle each year as summer fallow may be used for growing beans as an intertilled crop. This crop has been grown in parts of Nez Perce and Latah counties, Idaho, for the past 15 years, and the bean hullers make their regular fall runs the same as the grain thrashers. The crop has also been grown in a more limited way near Weston, Oregon, for 15 years. The production of field beans in this territory is therefore past the experimental stage. A few days spent in the vicinity of Kendrick, Idaho, visiting bean growers during the months of July and August will convince the skeptical of this fact.

Limiting Factors of Bean Production

Two factors largely determine whether beans may be grown successfully: (1) The annual precipitation must be sufficient to produce a crop each year and (2) the growing season from May 10 to September 15 must be approximately free from frosts. Owing to their proximity to the mountains the districts previously mentioned receive sufficient precipitation for growing beans when proper cultural methods are employed.

The deep ravines leading down from the mountains in these regions give protection from frosts during the growing season by furnishing excellent air drainage. While the danger from frosts increases with the elevation, air drainage is the principal regulating factor. In parts of Nez Perce county, Idaho, where the deep canyons furnish good air drainage, beans are being grown successfully at an elevation of 3,000 feet. In other parts of the same county having a lower elevation but poor air drainage, this crop can not be grown on account of the late spring and early autumn frosts.

The success of the bean crop also depends upon the quantity of moisture stored in the soil at the time of planting and upon the cultural methods employed in growing and harvesting the crop.

Cultural Methods Used in Bean Production

Experience has demonstrated that the success of the bean crop depends largely upon the thorough preparation of the seed bed. While it is not the general practice, the work of preparation should begin in the early autumn. The most successful growers work the grain stubble into the soil with a sharp disk harrow soon after the coming of the first fall rains. When the ground is plowed after such treatment the stubble is evenly distributed throughout the soil, where it quickly decays and prevents packing. It is not always possible to disk the stubble in the fall on account of the rush of work at that season. If, however, the plowing is delayed until the following spring, fall disking is very necessary.

Planting the Bean Crop

Time to plant.—The time of planting varies from May 10 to June 5, according as the season is early or late. When planted too early, cold weather, together with an excessive quantity of moisture in the soil, often causes the seed to decay before germination begins. Even if a good stand is secured under such unfavorable conditions the crop usually develops and ripens very unevenly.

Method of planting.—The double-row bean and corn planter is used almost exclusively for planting the crop. An excellent type of planter is now in use. This planter may be adjusted to plant in rows from 28 to 44 inches apart. By using a special 30-inch wire it will also plant the hills in 30-inch cross checks. The feed plates may be made to drop the desired number of seeds in each hill by regulating their speed. The planter is also equipped with an automatic hill-drop attachment which drops the hills from 17 to 52 inches apart in the row. If the ground is so foul as to require extensive cultivation the beans should be planted in checks with the hills 30 to 36 inches apart to permit cultivation in both directions.

It is considered very essential that the number of plants grown on a certain area be sufficient to maintain a proper balance between the soil moisture and the moisture requirements of the plants. If this balance is properly maintained the beans ripen evenly and a uniform crop is produced. In the sections where beans are being grown at present, from six to eight seeds in each hill produce the proper number of plants. If a smaller number of seeds is planted in each hill there is often moisture enough in the ground to keep the vines growing late in the fall, and the late beans are sometimes damaged by early fall frosts. This problem must be worked out, however, for each locality having different soil and moisture conditions.

A hand corn planter is often used for planting where only a small acreage is to be grown. The ground is marked off in checks about 30 inches square and the beans dropped at the intersection of the marks. An experienced man can plant from four to seven acres a day by this method. If the ground is free from weeds, so that but little cultivation is necessary, the seed is often planted in drill rows with either a bean planter or an ordinary grain drill. Of the two, a bean planter which has a drill attachment is the more desirable.

A grain drill having feed cups which will handle beans may be used with fair success. An 11-row grain drill with a space of seven inches between each drill tube can be adjusted for drilling beans in rows 28 inches apart by stopping up all of the feed cups except the second, sixth and tenth. The machine is so regulated as to plant the seed from three to six inches apart in the row.

The depth at which the beans are planted depends upon the character of the soil and the weather conditions. They are not planted so deep in dark, heavy soil as in a lighter soil. Neither can beans be planted to a very great depth during cold, damp weather without injuring the stand. The safe plan is to plant just deep enough for the seed to lie in moist earth, for an even stand of strong, healthy plants is one of the first requirements of a good bean crop.

Quantity of Seed Per Acre

The quantity of seed required per acre depends upon the size of the beans and also upon the manner of seeding. The pea bean varieties, such as the Little Navy, the Lady Washington, and the Red Miner, require from 16 to 20 pounds per acre when planted in checks 30 to 36 inches square. If planted in drills or checked closer than this a larger quantity of seed will be necessary. The larger seeded varieties require more seed per acre than the smaller varieties.

Beans as a Truck Crop in the South

W. P. Williams

The raising of bush or snap beans, as they are called, is becoming a prominent industry in some sections. The bean adapts itself readily to companion cropping; has a short period of growth (60 to 70 days); is fairly easy to grow, and is thus gaining favor as a truck crop.

Beans may be grown on any garden soil, but a rich sandy loam, with porous subsoil is preferable for early crops. Land for this crop should be manured and plowed as soon in the spring as possible. It should be disked and harrowed until it is well pulverized, and if planting is delayed harrow every week until ready to plant.

The bean, being a leguminous plant, does not need heavy application of nitrogen. An application of the following amount of fertilizer per acre will give very good results, and is a 9-2½-5 goods:

Acid phosphate (16 per cent)	300 lbs.
Cotton seed meal	200 lbs.
Muriate of potash	50 lbs.

Some growers use only cotton seed meal at the rate of 700 pounds per acre, and a dressing of 100 pounds of nitrate of soda at blossoming time. By the above method the succeeding crop gets the benefit of fertility not available for the present crop.

Beans are sown in drills four feet apart and quick maturing crops, such as radishes, are planted between the rows or later crops, like cotton, corn or potatoes, are planted when the beans have reached maturity. Many growers practice sowing a successive crop of beans between the rows.

Cultivation should begin as soon as the plants push through the ground, and this should be continued at frequent intervals throughout the growing period. The cultivation should be shallow, and the soil should be ridged slightly toward the plants.

The seed is sown in drills and covered about two inches. Seed sown early is apt to rot, so it should be sown quite thickly. One quart of seed will plant from 80 to 100 feet of rows. Early sowings are apt to be caught by frost, as the young plants are very tender, but the prices of early shipments are so good that some risk may be run to receive these high prices.

Varieties recommended for the South are Red Valentine, Stringless Green Pod, Refugee and Golden Wax. Pole varieties such as Kentucky Wonder and Old Homestead are good, as they last over a longer season than the bush varieties.

Beans are ready to harvest from eight to ten weeks after planting. The beans are picked when of sufficient size, but they are not allowed to become tough and stringy. Never pick beans when the foliage is damp, as many growers claim this causes rust and anthracnose to spread more rapidly. Anthracnose is controlled by growing seed which is desired for planting the following spring, in the fall; if there should be some disease in the fall crop, select seed only from healthy pods, and follow the recommendations as given above for cultivation and picking.

The beans when picked are sorted and packed in hampers holding about seven-eighths of a bushel and are then loaded into refrigerator cars. The cost of shipping a car to Northern markets is about $125, and the cost in these car lot shipments is about 30 cents per hamper.

A good yield of beans is 150 hampers per acre, and prices are sometimes as high as $3.00 and more per hamper, for very early shipments. Many growers figure that the crop of beans pays all the fertilizer and necessary expenses for the culture of the succeeding crop, and thus the price received for the latter crop is clear profit.

BEAN DISEASES

Anthracnose—Spot

Colletotrichum sp.

Causes large, scabby, dead spots upon the pods.

May be controlled by selecting clean seed and spraying the plants with Bordeaux mixture.

Bacterial Spot—Blight

Bacterium phaseoli Erw. Sm.

Leaves, pods and stems show watery spots. Not so prevalent on new land.

Powdery Mildew

Erysiphe polygoni

Produces a white growth of the fungus covering the surface of the leaves in moist weather.

Sprinkle with dry sulphur.

R. E. Smith,
Berkeley, Cal.

Rust

Uromyces appendiculatus

Causes a yellowing and death of the leaves with the production of a dusty red rust on the under side. Not usually destructive except on plants growing poorly.

R. E. Smith,
Berkeley, Cal.

BEAN PESTS

Bean Aphis. See *Aphids*.

Bean Cutworm

Ogdoconta cinereola Gwen.

The caterpillar of this species does injury to the foliage and pods of beans, at times stripping them. The larvae is a looper, pale green with three white strips and measures, when full grown, about an inch.

It is distributed pretty well over the country east of the Rockies, but has been destructive so far only in Florida and Mississippi.

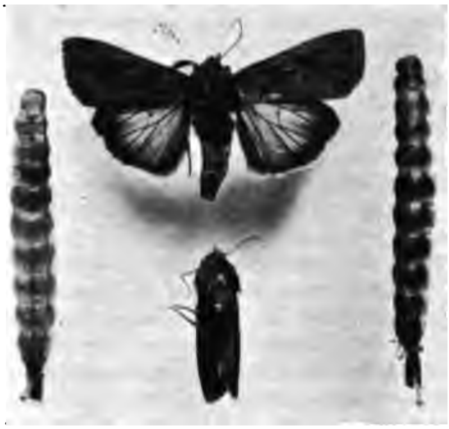

Fig. 1. The Common Cut Worm *Peridroma Margaritosa.* —*After Essig.*

Arsenical sprays will control it though care should be taken to thoroughly clean the pods if they are to be eaten.

Bean Weevil

Acanthoscelides obtectus Say

Family Bruchidae.

Bruchus obtectus Say

General Appearance

The adult weevils are very short and robust, measuring about one-eighth of an inch in length. The odd shape is due to the wing covers being shorter than the abdomen, and the head being carried at right angles to the body. The color varies from gray to brown with a velvety greenish tinge. The eggs are white and less than a millimeter long. The grubs are very small, a number of them being able to occupy a single small white bean. They are light cream colored and robust. The pupae are first light, gradually becoming darker with age.

Life History

The adult beetles after hibernating or breeding in stored beans over winter appear in the spring about the time the beans are blooming and lay their eggs upon the pods, in cracks at the end or in slits made by the female's jaws. Upon hatching the young larvae bore through the pod or reach the beans within through a natural crack and begin to enter them by drilling a small hole, the entrance of which either heals over or is so small as to be unobserved. Once within the bean the entire life history is spent there, the adults emerging at will by cutting a circular hole in the side. The adults of the first brood immediately begin egg laying upon the pods as did the hibernating females in the field, but if in storage bins or sacks the eggs are laid upon the seed beans or in old burrows. They thus continue to breed throughout the entire summer and winter if the weather is not too cold, many generations appearing each year.

Distribution

This insect is generally distributed throughout the state, and is particularly troublesome in the central and southern counties where small beans are raised.

Foods

Nearly all varieties of beans are attacked by this weevil, though the small white and brown varieties are preferred. Limas are not usually affected, but occasionally they are attacked. Peas are also included as a host.

Control

The first step in the control of this pest is to harvest the beans just as soon as possible, for those left in the fields are sure to become largely infested. If any of the insects are discovered the beans should be thoroughly fumigated with carbon bisulfid before they are stored. If weevils appear in the bins or sacks, fumigation should be resorted to at once.

E. O. Essig

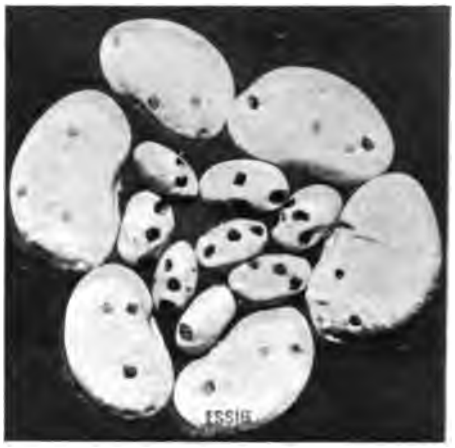

Fig. 1. The Work of the Bean Weevil on Small White and Lima Beans. (Original.)

Bean Thrips

Heliothrips fasciatus Pergande

General Appearance

The adult insect is black with head and thorax dark brown; antennæ are whitish with tips dark; legs are black and yellow; front wings are blackish with white base; posterior wings uniformly yellow with dark fringes. The young stages are lighter in appearance than the adult.

Life History

According to H. M. Russell, the insects hibernate in the adult stage only, under leaves, rubbish, etc. The eggs are inserted in the leaves or tender stems. The young begin feeding soon after hatching. When ready to pupate the larvae seek shelter under rubbish or in the ground, where the nymphal stage is completed

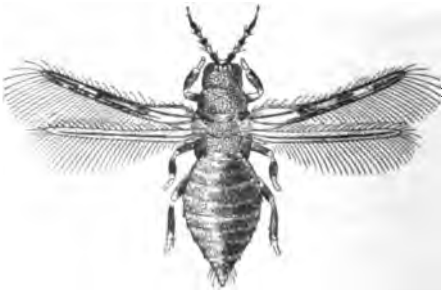

Fig. 1. Bean Thrips. (Enlarged)
—*After Russell*

and the adults emerge. There is an overlapping of broods so that during the summer months all stages may be found.

Distribution

The bean thrips are found in Idaho, California, Arizona and Kentucky.

Food Plants

Due to its large numbers this insect has proved a serious pest to oranges, alfalfa, pear trees and various garden crops, the work being the same as that of other members of the family.

Control

Control measures for this pest are the same as recommended for pear, citrus or grain thrips, depending upon the plants which are infested. See Pear.

A flour paste consisting of from six to eight pounds of cheap flour to 100 gallons of water and applied thoroughly has given excellent results in controlling this pest upon truck crops, such as beans, peas, beets, etc., which have tender foliage.

E. O. Essig

Flea Beetle

Systena blanda

Several flea beetles attack field beans. Probably the most troublesome is the pale-striped flea beetle. It is only during hot, dry summers that these tiny creatures make their attacks, but at such times they are likely to appear in myriads in fields of beans and sugar beets, as well as in all sorts of garden truck.

The name flea beetle is suggested by their habit of jumping when disturbed, very much like a flea.

The beetles themselves are only about one-eighth of an inch in length and creamy in color, with thin, longitudinal stripes of light brown on the wing covers. The larvae are slender, thread-like creatures, white in color with yellowish heads. They feed underground on the roots of weeds for the most part.

The effect of many tiny beetles eating holes in the foliage is to shrivel the leaves and, if the plants are very small, to kill them outright.

Remedies

The beetles winter as adults, which at once suggests the burning of rubbish about the farm and in the fence corners.

Bordeaux is a very valuable repellent. Bordeaux, however, is apt to burn the leaves of beans and arsenate of lead is probably the safest and best remedy.

R. H. Pettitt,
East Lansing, Mich.

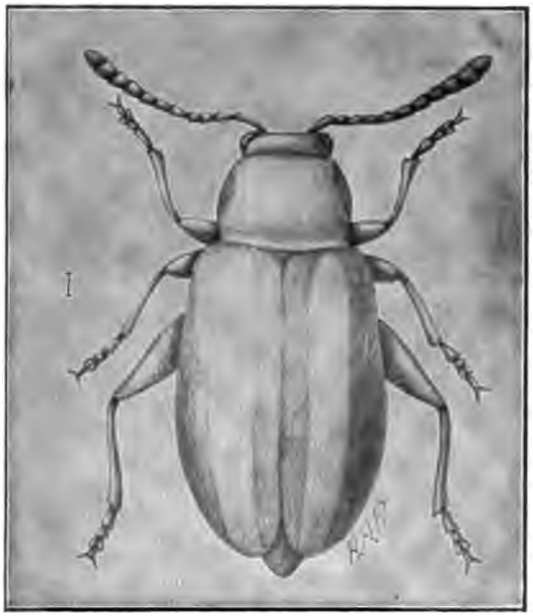

Fig. 1. Pale Striped Flea Beetle. Enlarged.
(Author's illustration.)

Four-Spotted Bean Weevil

Bruchus quadrimaculatus

An old enemy of cow peas. It also works in the common bean and, like the common bean weevil, it works indefinitely in the stored seeds until nothing of value is left. As this beetle is larger than the bean weevil, its work is comparatively rapid.

Like the bean weevil, this creature starts work in the field, coming into the granary with the harvested beans, or it may gain access after the beans have been stored away.

Remedies

Fumigation of the seed during warm spells with carbon bisulphid is the best remedy thus far discovered.

R. H. Pettit,
East Lansing, Mich.

Harlequin Cabbage Bug. See *Cabbage.*

Ladybird

***Epilachna corrupta*, Muls.**

The beetles belonging to the ladybird family are quite common in this section. They are small oval or hemispherical in shape and are red and brown with black spots or black with red or yellow spots. These beetles are divided roughly into two classes, beneficial and injurious. The beneficial species feed on plant lice and scale insects. The ladybird is troublesome throughout New Mexico and occasionally it becomes very injurious, especially to the bean crop. This beetle devours all parts of the bean plant in both the larval and adult stages. The yellowish brown eggs are laid in clusters on the under surface of the leaves.

The larvae has a yellow color and is covered with ugly branched spines. The matured beetle is light yellowish brown with eight black spots on each wing cover. This beetle is the one locally known as *La chinche del frijol* by the Mexican bean growers. The insect winters over in the adult stage and so far as it is known there is but one brood a year. It seems that in New Mexico the wintered over beetles appear about the last of June to the middle of July and the generation from these is developed in August and September.

Remedies

By judiciously using Paris green and arsenate of lead many of the larvae and adults can be killed. Greater care should be taken when using Paris green, since it is liable to injure the foliage. Kerosene emulsion is sometimes used with quite a degree of satisfaction. In small gardens hand picking of the first beetles in the summer and destroying the eggs may aid considerably in reducing the number of the late brood. Clean culture, as destroying all weeds and rubbish in the field, fall plowing, and harrowing would undoubtedly reduce the number of adults that will winter over. As there seems to be but one brood and this is most troublesome to the late crop the injury could be materially reduced by planting the beans as early as possible.

Lima Bean Pod Borer

***Etiella zinckenella* Treit.**

Family Pyralidæ

General Appearance

The adult moths are gray with ocherous blotches on the fore wings. There is a

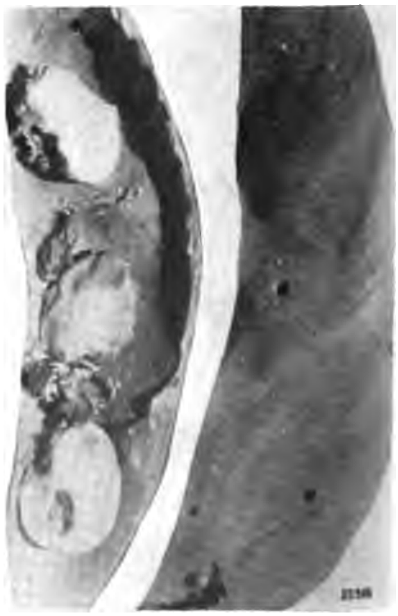

Fig. 1. The Work of the Lima Bean Pod Borer, *Etiella zinckenella* (Treit), on Bush Lima Beans. (Original.)

plain, broad, white band along the margins of these wings and an ocherous band with brown spots across the inner fourth. This band is especially conspicuous. The hind wings are light gray. The moths are small, scarcely more than one-half inch long. They are exceedingly active on wing and foot. The pupa is rich brown and usually enclosed in a thin white cocoon. The young larvae are white or light green. When full grown they are white or distinctly reddish above and greenish beneath. The head is dark as is also the prothoracic plate and the legs. They average about one inch in length. When disturbed they wriggle violently.

Life History

The writer has never seen the eggs so is unable to state where they are deposited, but judging from the observance of their work they are probably laid upon the bean plants and the pods as soon as they are formed. As soon as hatched the young caterpillars bore through the pods and begin feeding upon the beans inside, all of which are usually gnawed into or destroyed before fully developed. When ready to pupate the larvae either do so in the pod or select some other place. Very often they crawl into the ground and pupate under clods or any convenient shelter. As a protection a thin white cocoon is spun. In this stage some of the insects hibernate though many appear as adults in late summer and fall. There is but one brood a year. The adults appear in the spring about May.

Distribution

Apparently across the southern half of the United States and in Europe.

Food Plants

The beans in the pods of the small bush lima beans are the favorite food for this moth, though it occasionally attacks those of the large limas.

Control

Early beans are the ones suffering from the attacks of the caterpillars, though the later plantings do not escape. As the bush lima is usually the only crop attacked it would be well to plant the large and later varieties instead.

E. O. Essig

Red Spider. See *Apple Pests.*

Seed Corn Maggot

Pegomya fuscicepe

One of the causes of failure of germination of seeds in the ground is the seed corn maggot, otherwise known as the bean maggot. It is said to attack the seed of peas, corn and beans, and also to work on a varied list of plants including pumpkin, cotton, orange, artichoke, strawberry, cabbage, beets, onion, mustard and other plants.

The attack is most serious when made just after the germination of the seed. Later attacks are less apt to kill outright, though naturally they are bound to diminish the crop. With the young beans the attack is likely to occur just as the beans are nicely appearing above the ground. The cotyledons are blackened and the young central shoot often is shrivelled and dead. Maggots are often to be found in the decaying cotyledons or in the fleshy stems beneath the surface of the soil. This occurs during the first part of July. The adult flies appear in the third week in July.

The maggots appear very much like those of the onion maggot and those of the cabbage maggot, being white, tapering, and about one-fourth of an inch long. The adult fly looks like a miniature house fly, being about one-fifth of an inch long.

The seed corn maggot is credited with breeding in decaying vegetation and also in fresh manure.

Remedial Measures

The standard repellents, sand and kerosene, and carbolic acid emulsion can be used when the beans are in the garden, just as in the case of radish and onion maggots. However, in the field, such methods are hardly practicable. The avoidance of freshly applied stable manure and the substitution of commercial fertilizers during the year that beans are raised on a given piece of ground, should prove beneficial when the maggot has once made trouble. Of course beans should never be planted where the maggot is known to have been recently, nor in fact should they be planted in very close proximity to a recent outbreak.

R. H. PETTIT,
East Lansing, Mich.

TWELVE SPOTTED CUCUMBER BEETLE. See *Cucumber.*

BEANS, VELVET. See *Apple Orchard Cover Crop.*

Bees

Before discussing the subject of bees in the orchard, we will describe briefly the nature of bees in general; because it is only when we understand them that we are prepared to appreciate their relations to things affected by them.

Bees, like most animals and plants, are divided into families, species and varieties. Of the bees there are two distinctive families. The first is called, scientifically, *Andrenidea*, or Solitary Bees, having the underlip flattened and very short. The second is called *Apidae*, and are social in their instincts. The *Andrenidea* excavate nests in the turf, the grass and other substances in the fields, even making a deep pipe or hole with short lateral galleries in which the grub feeds and grows. These bees entertain guest bees called *Nomada*, so called because they lay their eggs in the nests of the *Andrenidea* where the young are hatched and share the food of their hosts as visitors share the food of friends. Here the adults seem to live harmoniously together, grow their young and sustain relations which seem more like a partnership than a case of parasitism.

The *Apidae* includes the Bumble Bee, the Carpenter Bee, Stingless Bees, and Honey Bees. The *Bombus*, or Bumble Bee, are familiar to all American boys, especially those who have lived in the country in the Middle or Eastern states. Upwards of fifty species of this bee inhabit North America; there are very few in South America, and none in Africa south of the Sahara, or in Australia; while they are the only bee inhabiting the Arctic and Alpine regions. This bee is sometimes called the Humble bee, and is recognized by its large, thick, hairy body and deep bass hum. The colonies of Bumble bees are not numerous as compared with those of the Honey bee, but they are more vicious and the sting is very severe. Their colonies are not large, perhaps not more than one-tenth the size of the colonies of the Honey bee. In good weather and when the flowers are abundant they collect honey and store in the cells from which the young were hatched.

The Carpenter bee, called in science *Xylocopa-virginica*, is called the Carpenter bee because it bores in the wood of dead trunks of trees, lumber, and sometimes in buildings. It is a large black bee, as large as the Bumble bee or sometimes larger. It bores horizontally across the grain of the wood, then turns and runs sometimes from one to two feet at right angles. When the cells are completed they are supplied with pollen and separated from each other by sawdust or dust which the bees formed in making the cells, and this dust is glued together with a wax which they supply. When the cells are finished an egg is deposited in each cell; when the egg is hatched the larvae feed on the pollen until they are able to bore their way out of the cell. A Carpenter bee will sometimes use the same home for several hatchings, and the place is often occupied by other bees.

The Stingless bee is sometimes called *Melipona.*

The Honey bee is called *Apis Melifica.*

The leading feature in the natural history of bees, and one which distinguishes them from all other insects is their singular distribution into three different kinds, constituting, to all appearances, so many modifications of sex. The drone, which has a thick body, a round head, a more flattened shape, and a more obtusely terminated abdomen, within which are contained the male organs of generation, is undoubtedly the male of the species. It is distinguished also by the absence of a sting and by the humming noise that accompanies its flight. The queen bee has a sting, has a larger abdomen than the others, and is larger and more graceful. Her work is to lay the eggs for the new colony or generation. The worker bees are small, having a long proboscis, used for extracting nectar from the flowers, peculiar shaped legs for carrying pollen to be worked into cells or bee-bread, and have only rudimentary generative organs. They construct the interior of the cells, explore the country in search of food and honey, supply the queen, defend the hive, and carry on hostilities against enemies and depredators. The number of workers is much larger than that of the drones, generally not more than one in 30 or 40 is a drone or male, while there is only one developed female or queen. The workers do not present distinctly marked female organs, yet it is now understood that the workers are undeveloped females, and that any worker if taken in the early stages of its development and fed on the proper food can be developed into a queen with all of the sex organs perfect.

How the Bee Stings

The sting consists of a finely pointed tubular instrument open along the whole length of its upper surface. This opening is closed by two horny slender barbs, each having about 10 serrations or notches in its outer edge. These barbs are not projected in advance of the sting as is sometimes supposed, but complete its outer tubular surface down the center of which the poison is injected from a little bag at the root of the sting. The serrations prevent the bee from withdrawing its sting from its enemy, but it is torn from the body with a portion of the intestines, causing the death of the bee. The poison poured into the wound from the sting contains certain pungent salts to which it owes its mischievous tendency.

How They Ventilate the Hive

Crowded into a small space in a box not more than 12 inches square, often with several thousand bees, the air would naturally become foul, and death would result were there not some system of ventilation. These little creatures cannot live in a foul atmosphere any more than could animals of larger size, yet so perfect is their system of ventilation that the air of the hive is little different from the surrounding atmosphere on the outside of the hive. This ventilation is effected by the vibration of the wings of a certain number of bees that fasten their feet to the floor of the hive and imitate the action of flying. The vibration of their wings drives the air out of the hive with a current of considerable force, and the fresh air coming in to fill up the vacuum purifies the atmosphere. These bees continue their motions for from 20 minutes to half an hour, when others take their places to be again relieved by others. This is the occasion of that humming sound heard in the hive when the bees are in a state of activity. The immediate cause of the action of ventilation is supposed to be the impression made on the organs or the nervous system by the vitiated air, for a bee can be made to ventilate itself outside the hive if it is brought into contact with substances that have to it an unpleasant odor.

The Bees and the Orchard

Anyone who has studied the subject of the pollenization of flowers, and who knows the important work performed by insects, especially by bees, in fertilizing the orchards, causing the process of germination and the production of fruit, will know that bees are of exceeding importance in fruit growing.

Any student of botany understands that flowers are sexual, and that in order to produce seed or fruit the pollen from the male must be conveyed in some manner to the stigma of the female, and that by the union of the two the process germination begins. But how is this effected? Flowers are fastened by their stems to the limbs on which they grow and cannot mate as do insects and animals. The only possible method, therefore, by which fertilization takes place is that of conveying the pollen grain from the one to the stigma of the other.

There are two classes of flowers, those that are self-pollinating and those that must be cross-pollinated. The self-pollinating flower produces its own pollen, while the cross-pollinating flower must receive the pollen from others, and generally from other trees or plants. There are two ways in which the pollen can be conveyed from the one to the other. The first is by the wind, which is exceptional, the second is by insects, generally by bees gathering nectar from the flowers. In the process of gathering food the pollen is scattered in minute particles upon the feet, head and organs of the bee, carried from one flower to the other, and deposited where it is suited to the process of germination.

The importance of pollen carrying insects cannot, therefore, be over-estimated. Yet, there is at present a difficulty in the successful keeping of bees that feed upon the nectar from orchard flowers, on account of the fact that the spraying for codling moth must be done after the petals of the flowers have fallen and before the calyx cup closes. At this time the spray should be forced into the calyx cup. If this is done and the bee gets the poison instead of the nectar it dies as surely as the codling moth would die if it entered the calyx cup. We may yet discover an insect that will feed upon the codling moth, and grow it in our orchards, as there have been in many cases discovered insects that feed upon others and destroy them, but until such discovery is made the spraying habit must continue in order to successfully grow fruits, and bee keeping in orchards will be more or less perilous because thousands of those little creatures will be killed by getting the poison intended for the moth.

At the present time we have no means of knowing how to fertilize our trees except through the aid of insects that carry the pollen, nor have we any knowledge of how to kill the codling moth that so seriously damages the fruit without the use of arsenate of lead or some other poison. However, we believe it profitable, with all the dangers that accompany it, to keep bees in orchards, for while many of them will be killed, many will also survive, and the principal profit will be, not so much in the honey which they produce, as in the fertilization of the trees.

The Sense Perception of Bees

How They Hear, See, Smell, Feel and Taste.—We quote the following from the Encyclopedia Britannica:

"The physiology of the sense perceptions in a class of animals of a nature so remote from our own must necessarily be very imperfectly understood by us. The great diversity of character presented by the different tribes of insects, as well as of other animals, naturally suggests the idea that external objects produce on their sentient organs widely different impressions from those communicated to ourselves. The notions that we form of

Fig. 1. A Profitable Colony of Bees in the Yakima Country.
—*Courtesy N. P. Ry. Co.*

their senses must not only be liable to great inaccuracy, but may often be totally inadequate representations of the truth. A finer organization and more subtle perceptions would alone suffice to extend the sphere of the ordinary senses to an inconceivable degree, as the telescope and the microscope would with our vision. But they possess, in all probability, other organs appropriated to unknown kinds of impressions which must open to them avenues to knowledge of various kinds to which we must ever remain strangers. Art has supplied us with many of the properties of matter which nature has not immediately furnished us with the means of detecting, but who will compare our thermometers, spectroscopes, hygrometers, however elaborately constructed, with those refined instruments with which the lower animals, and particularly insects, are so elaborately provided."

The antennae which is so generally observed in this class of animals, look like horns, and yet are so delicately adjusted that they are believed to be the organs of both feeling and hearing, and are most highly sensitized. They are believed to be sensitive to all the vibrations and changes in the air; they are exceedingly flexible, and may be the organs also of some sense of which we know nothing. Aided by these the bee works in the darkness with perfect accuracy, and builds its comb, pours honey into its magazines, feeds the larvae, and communicates its impressions. With this organ, it speaks a kind of language which seems capable of various modifications, capable of supplying every sort of information of which they are possessed. They have the sense of vision, but during the night they seem guided by a sense located in the antennae; they have the sense of smell, and are attracted by the aroma of the flowers or repelled by disgusting odors or a bad atmosphere. Their perceptions of heat and cold are exceedingly delicate. The influence of the sun's rays excites them to vigorous action; a moderate degree of cold will reduce them to a state of torpor, and even the slight changes from heat to cold are unpleasant to them. Forty degrees of temperature will so benumb a bee as to deprive it of the powers of flight. It is this, more than anything else, we believe, that in the Pacific Northwest in the spring of 1911 prevented the pollination of the orchards. For weeks together at the time the blossoms were forming the cold was, for that season of the year, unusually severe, and it was only occasionally that the mercury rose above 40 degrees of temperature. Not being able to work, the bees could not therefore carry the pollen from one tree to another, and many of the trees were not pollinated. In the hive where the bees are in their usual winter quarters they will live in a temperature 20 degrees below zero, and from the condensed vapor in the hive they are often found in a solid lump of ice; yet, with returning spring, they awake to activity. They are exceedingly sensitive to changes in the humidity of the atmosphere, as well as to changes of heat and cold, and can even portend approaching storms when no human sense can detect it. Perhaps the least sensitized of their organs is that of taste. They will extract their food from various things that, from our viewpoint, would be exceedingly disgusting, but otherwise perhaps not more so than many things which we relish.

The Sociology of the Bee

In a colony of bees there are proper divisions of labor, each class doing that to which it is by nature best adapted, and all doing something. There are no useless classes in a hive of bees. It has been said that the drones are parasites and are practically useless because they are not workers. It has been charged against them that they feed on the product of the labor of the workers without rendering a just equivalent for what they receive. This is true only in the sense that the useful period of the drones passes with the fertilization of the queen, and when their work is done it may be said that they are no longer useful. After this work is completed, before entering into winter quarters the drones are cast out of the hive or mercilessly killed. This is perhaps an economic measure, and seems to be performed in order to leave sufficient food to the workers and to the young. Under conditions where the food is scarce and the question is one of sufficiency for the life of the colony, this habit enables the colony to survive where others would die. Viewed from the standpoint of the class, the killing of the drones or males is unmerciful and unjust; but viewed from consideration of the good of the colony as a whole, the action is justified.

Objection to Bees in Orchards

An objection urged is that they carry blight from tree to tree. This is doubtless true, but the remedy here is, to cut out the blight. I do not conceive it possible to fertilize the flowers without bees, or some other insects which do the work of bees, even though it be true that they are carriers of blight. Some of our best orchardists think that there should be a colony of bees for every 50 trees in an orchard, while others think one colony for 100 trees is sufficient.

GRANVILLE LOWTHER

BEE KEEPING

FRANK BENTON

In Charge of Apicultural Investigations
United States Department of Agriculture

Locations Suited to the Keeping of Bees

It may be safely said that any place where farming, gardening, or fruit raising can be successfully followed is adapted to the profitable keeping of bees—in a limited way at least, if not extensively. Many of these localities will support extensive apiaries. In addition to this there are, within the borders of the United States, thousands of good locations for the apiarist—forest, prairie, swamp and mountain regions—where agriculture has as yet not gained a foothold, either because of remoteness from markets or the uninviting character of soil or climate. This pursuit may also be followed in or near towns and, to a limited extent, in large cities. It even happens in some instances that bees in cities or towns find more abundant pasturage than in country locations which are considered fair.

The danger of overstocking a given locality is very frequently exaggerated. Each range, it is self-evident, has a limit. The writer is, however, fully convinced, after long experience in numerous localities and under the most varied circumstances, that three or four times as many colonies as are commonly considered sufficient to stock a given range may usually be kept with a relative degree of profit. But to secure such results sufficient care and close observation have too frequently not been given in the selection of bees adapted to the locality and conditions.

The Returns to Be Expected from an Apiary

Aside from the pleasure to be derived from the study of these interesting creatures, what returns can one who is well adapted to such work expect to derive?

A moderate estimate for a fairly good locality would be 35 to 40 pounds of extracted honey or 25 pounds of comb honey per colony. This presupposes good wintering and an average season. By locating in some section particularly favorable to apiculture—that is, near large linden forests, with clover fields within range, supplemented by buckwheat; or in a section where alfalfa is raised for seed; where mesquite, California sages and wild buckwheat abound; where mangrove, palmettoes and titi, or where sourwood, tuliptree, and asters are plentiful—these returns may frequently be doubled or trebled. But these favored locations, like all others, are also subject to reverses—the result of droughts, great wet, freezes which kill back the bee pasturage, etc. On the whole, there should be expected from the raising of bees for any purpose whatever only fair pay for one's time, good interest on the money invested, and a sufficient margin to cover contingencies. With no greater expectations from it than this, and where intelligence directs the work, apiculture will be found, in the long run, to rank among the best and safest of rural industries.

The value of bees in the pollination of various fruit and seed crops is often sufficient reason to warrant the keeping of a small apiary, even if circumstances do not favor its management in such a manner as to secure the largest possible crops of honey or to insure the saving of all swarms.

Anyone Who Desires to Do So Can Learn to Manipulate Bees

Any person with fairly steady nerves and some patience and courage can easily learn to control and manipulate bees. There are, it is true, a few exceptional individuals whose systems are particularly susceptible to the poison injected by the bee, so much so that serious effects follow a single sting. Such cases are, however, very rare. In most instances where care is not taken to avoid all stings the system eventually becomes accustomed to the poison, so that beyond momentary pain a sting causes no inconvenience.

How to Avoid Stings

Stings can be avoided, first, by having gentle bees. If no other point of superiority over the common brown or black bee than that of gentleness could be fairly claimed for some of the races introduced and some of the strains developed in recent years, it would still be worth while to get them on this account alone. When the fact of superiority in several other important points is considered also, there should be no further question as to the advisability of procuring them in preference to the common variety.

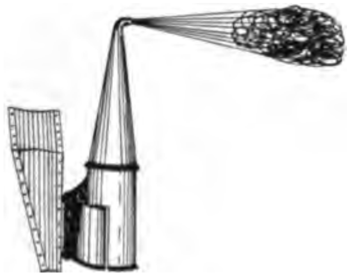

Fig. 1. The Bingham Bee Smoker.

Of the races already in general cultivation, Carniolans are the gentlest, although Caucasians, more recently introduced from Southeastern Russia and only now being put on sale, are by far the least inclined to sting of any bees, and may be handled at all times without resorting to the protection of a bee veil, and generally without smoke, or at most, a very slight application of smoke. Some strains of Italians equal in gentleness average Carniolans, but in general the race native to Italy is by no means as gentle as that found in Carniola, Austria, and the Caucasians are much to be preferred for the beginner. In case these gentler races are not easily procurable he need not hesitate, however, to undertake, after adopting due precautions, the manipulation of pure Italians.

In crossing well-established breeds the males of a gentle race should be used, otherwise the workers of the cross may vary greatly in temper, especially in the first few generations. Only careful selection continued for some time will so fix the desirable traits as to result in their reproduction with a fair degree of certainty in the offspring. Bees having the blood of blacks and Italians are nearly always quite vicious in the case of the first cross, and are even harder to subdue with smoke than are pure blacks. Other races need not be considered here, as they are adapted to special purposes; and the skill of the bee master, the conditions of climate, flora, etc., and the particular line of production to be followed, should decide whether their introduction is advisable or not.*

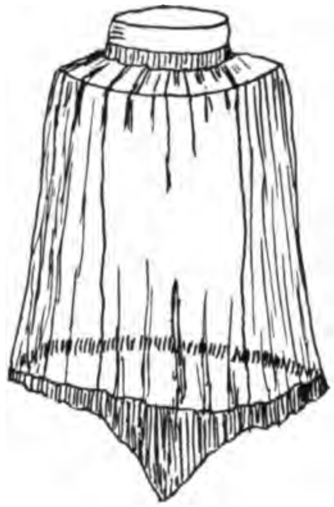

Fig. 2. Bee Veil.

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* For a fuller discussion of this subject, see "The Honey Bee: A Manual of Instruction in Apiculture," by Frank Benton, M. S. Bulletin No. 1, new series, Bureau of Entomology, U. S. Department of Agriculture, third edition, 1899, Chapter I, pp. 11-18.

The second essential to enable one to avoid stings is to have a good smoker at hand whenever the bees are to be handled. For ease and effectiveness in keeping bees under control nothing will take the place of the modern bellows smoker (Fig. 1). A good one lasts years, and its cost is so slight ($1 to $1.25 for the medium sizes) that the expenditure may be considered one of the wisest that can be made in fitting up an apiary.

A veil (Fig. 2), made of black bobinet or Brussels net, to draw over the hat, and a pair of gloves, preferably of rubber, may be used. The veil can be safely dispensed with if the gentlest bees are kept.

Simple and convenient hives, employing the Langstroth principle, and with stories and frames interchangeable and so constructed as to reduce propolization to a minimum and to insure straight combs, will much facilitate the avoidance of stings.

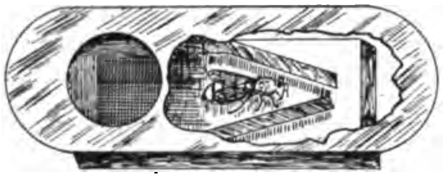

Fig. 3. The Porter Spring Bee Escape

The use of the bee escape (Fig. 3) in removing surplus honey greatly reduces the risk of being stung during this operation, for it saves much manipulation of combs and shaking and brushing of bees. This useful device is fitted into a slot made in a board the same size as the top of the hive, and the whole, when slipped in between the brood apartment and an upper story or super, will permit all of the workers above to go down into the lower story but not to return to the top one, so that in one night it is possible to free entirely a set of combs from bees without any manipulation of the combs, and without smoking, shaking or brushing the bees.

What Race of Bees to Choose

As the gentler races are excellent honey gatherers the beginner should adopt only these—either Caucasians, Carniolans, or Italians. Should full colonies not be obtainable, colonies of ordinary bees may be changed by replacing their queens with queens of the desired race, the latter having been procured in small boxes by mail.

A brief summary of the leading traits of the various races now in this country will be of use in guiding the purchaser.

Caucasians are natives of Southern Russia, are exceedingly gentle, good workers, good defenders of their hives, prolific, build many queen cells, and swarm often if confined to small hives. The workers are dark leaden gray in their general color, and present quite a ringed appearance because of the alternation of this dark color with the lighter fuzz which edges the segments of the abdomen.

Carniolans are much larger bodied and somewhat lighter gray in color than the Caucasians. Their great hardiness and excellent wing power enable them to fly freely in much cooler weather than some other races stand, and to regain their hive entrances under adverse conditions. They are prolific, active, and good honey gatherers, producing combs of snowy whiteness.

Italians, the first of the foreign races to be introduced into this country, are much more widely known, and have with reason found great favor, since they are industrious, good defenders of their hives, and excellent honey gatherers, as well as handsome in appearance, being usually evenly marked with three yellow bands across the anterior portion of the abdomen.

Cyprians, from the island of Cyprus, may be taken as a general type with which to compare other Eastern races. They are small bodied, more slender, in fact, than any of the European races of bees. The abdomen is more pointed and shows, when the bees are purely bred, three light-colored bands on the upper surface, and considerable yellow on the under side. Cyprians possess longer tongues and greater wing power than other races. This, combined with great prolificness and most remarkable activity, renders them the best of honey gatherers. In temper, however, they may be regarded as rather aggressive, rendering their management by any who are not experts extremely difficult.

Cyprio-Carniolans and Cyprio-Caucasians.—Bees combining the blood of the first two races in various proportions have been tested for years in comparison with all other known races, with the result that the cross mentioned above has been found to exceed all of the pure races in honey-gathering powers, owing undoubtedly to the combination of great energy, hardiness, prolificness, and wing-power, as well as greater length of tongue —a fact established by actual measurements. Similar results, with even greater gentleness, may be expected from the cross obtained between Cyprian queens and Caucasian drones.

Syrian and Palestine or "Holy-Land" Bees.—What has been said of Cyprians may be taken to apply in a general sense to Syrian and Palestine bees, except that in these the good qualities are slightly less prominent, while some of the bad ones of the Cyprians are accentuated.

German, Common Black, or Brown Bees. —The bees commonly found wild, and cultivated to a greater or less extent, in this country, and known under the above name, are probably derived from early introductions from the Old World. In comparison with the races above enumerated, they may be said to be inferior, since they possess the least energy in honey collecting, are less prolific, and not as good defenders of their hives. Under favorable conditions, however, as regards pasturage they may be relied upon for excellent results. They are, however, spiteful under manipulation, and have the disagreeable habit of running from the combs and dropping in bunches on the ground, likewise or flying from the hive entrance and attacking passers-by. They are more easily discouraged than other bees during slack times as regards honey production, and this is doubtless the main reason for their generally inferior economic value.

What Hive to Adopt

The suspended Langstroth frame is used more than any other frame among English-speaking bee keepers. There being no patent on the Langstroth hive, and accurately made hives being obtainable at moderate prices from hive factories in various parts of the country, it is taken for granted that the enterprising beginner will adopt a simple form embodying this principle—the loose-fitting, suspended comb frame—as its main feature. The hive should not only be substantially built, but should have accurate bee spaces and a close-fitting, rainproof cover or roof. Factory-made hives, as a rule, best meet these requirements, as both lock joints and halved corners can only be made to advantage by machinery, and the expert hive builder understands, of course, the absolute necessity of great accuracy in bee spaces, as well as the great desirability of good material and workmanship. Provision should also be made for winter protection.

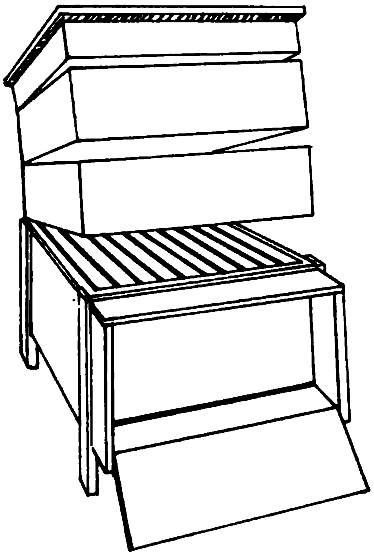

Fig. 4. Langstroth Hive with Two Half-depth Supers for Surplus Honey.

For comb honey, hives permitting the insertion in the brood apartment of any number of frames up to eight, or frequently up to ten, are most in use. In securing extracted honey, those with ten to 12 frames in each story are preferable, and as many stories, one above the other, are employed as the strength of the colony and a given harvest may require. A construction, therefore, which readily admits of expansion and of contraction, as occasion demands, is desirable.

Mention should be made of a hive of quite different construction, a prominent feature of which is this ease of contraction and expansion. It is the last hive which the late M. Quinby gave to the public—the Quinby closed-end frame hive. This hive is used with great success by certain American bee keepers of long experience and whose apiaries are among the largest in the world.

Management in Swarming

Natural Swarming

When a swarm is seen issuing or in the air, the best thing to do is, in general, simply to wait a bit. The weather is usually rather warm then, and rushing about to get tin pans, dinner gongs, spraying outfits, etc., aside from its disagreeableness, may get one so excited and into such a perspiration as to unfit him to do with the bees that which is likely to be necessary a few minutes later. The bees will probably gather in a clump on a tree or bush near the apiary and however formidable getting them into the hive may at first seem, nothing will be simpler than shaking them into their new hive, or into a basket or box, from which they may be poured in front of the hive, just as one would pour out a measure of wheat or beans.

The securing of swarms can be made, however, even simpler than this by having the colonies placed several feet apart on a smooth lawn or dooryard and clipping one wing of each laying queen so as to prevent her flying. The prime or first swarm from each hive is accompanied by the old queen, and if she be clipped she will of course fall from the alighting board to the ground and may be secured in a cage.

The parent colony removed to a new stand a rod or more away will rarely give a second swarm. But to make certain all queen cells except one may be cut out four or five days after the issuance of the first swarm.

Each after-swarm (second, third, etc.), it should be borne in mind, is accompanied by one or more unimpregnated queens, and these must not be clipped until they have flown out and mated. The regular deposition of eggs in worker cells may nearly always be regarded as a safe sign that mating has taken place. Eggs will usually be found in such cells within the first ten days of the queen's life.

Prevention of Swarming

Under the conditions most frequently occurring—that is, where it is not practicable to be present at all times during the swarming season, or where the desired number of colonies has been attained—a system of management is advisable which in general contemplates the prevention, insofar as possible, of the issuance of swarms without at the same time interfering with honey storing. The paragraphs following on this subject are taken from the department publication, "The Honey Bee."

The most commonly practiced and easily applied preventive measure is that of giving abundant room for storage of honey. This to be effective should be given early in the season, before the bees get fairly into the swarming notion, and the honey should be removed frequently, unless additional empty combs can be given in the case of colonies managed for extracted honey, while those storing in sections should be given additional supers before those already on are completed. With colonies run for comb honey it is not so easy to keep down swarming as in those run for extracted honey and kept supplied with empty comb. Free ventilation and shading of the hives as soon as warm days come will also tend toward prevention. Opening the hives once or twice weekly and destroying all queen cells that have been commenced will check swarming for a time in many instances, and is a plan which seems very thorough and the most plausible of any to beginners. But sometimes swarms issue without waiting to form cells; it is also very difficult to find all cells without shaking the bees from each comb in succession, an operation which, besides consuming much time, is very laborious when supers have to be removed, and greatly disturbs the labors of the bees.

If but one cell is overlooked the colony will still swarm. The plan therefore leaves at best much to be desired, and is in general not worth the effort it costs and can not be depended on.

Dequeening.—The removal of a queen at the opening of a swarming season interferes, of course, with the plans of the bees, and they will then delay swarming until they get a young queen. But to prevent swarming by keeping colonies queenless longer than a few days at most is to attain a certain desired result at a disproportionate cost. The plan is therefore not to be commended.

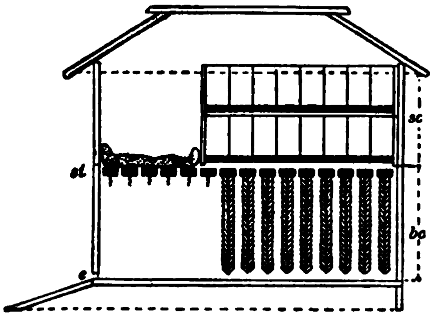

Fig. 5. The Simmins Nonswarming System—Single-story Hive with Supers: *bo*, brood chamber; *so*, supers; *st*, starters of foundation; *e*, entrance.

Requeening.—Quite the opposite of this and more efficacious in the prevention of swarming, is the practice of replacing the old queen early in the season with a young one of the same season's raising, produced, perhaps, in the South before it is possible to rear queens in the North. Such queens are not likely to swarm during the first season, and, as they are vigorous layers, the hive will be well populated at all times and thus ready for any harvest. This is important, inasmuch as a flow of honey may come unexpectedly from some plant ordinarily not counted upon; and also, since the conditions essential to the development of the various honey-yielding plants differ greatly, their time and succession of honey yield will also differ with the season the same as the quantity may vary. Young queens are also safest to head the colonies for the winter. The plan is conducive to the highest prosperity of the colonies, and is consistent with the securing of the largest average yield of honey, since, besides giving them vigorous layers, it generally keeps the population together in powerful colonies. It is therefore to be commended on all accounts as being in line with the most progressive management, without at the same time interfering with the application of other preventive measures.

Space Near Entrances. — Arranging frames with starters, or combs merely begun, between the brood nest and the flight hole of the hive, while the bees are given storing space above or back of the brood nest (Fig. 5), is a plan strongly recommended by Samuel Simmins, of England, and which has come to be known as "the Simmins non-swarming method," some features of it and the combination into a well-defined method having been original with him. It is an excellent preventive measure, though not invariably successful, even when the distinctive features brought forward prominently by Mr. Simmins—empty space between the brood combs and entrance, together with the employment of drawn combs in the supers—are supplemented by other measures already mentioned; but when, in addition to the space between the brood and the flight hole, the precaution be taken to get supers on in time, to ventilate the hive well, and to keep queens not over two years old, swarming will be very limited. If to these precautions be added that of substituting for the old queens young ones of the current season's raising, before swarming has begun, practical immunity from swarming is generally insured.

Selection in Breeding.—Some races of bees show greater inclination than others toward swarming, and the same difference can be noted between individual colonies of a given race; therefore, whatever methods be adopted to prevent or limit increase, no doubt the constant selection of those queens to breed from whose workers show the least tendency toward swarming would in time greatly reduce this disposition.

Economic Plants and Trees for Cultivation for Honey and Pollen

Except as a means of bridging over gaps in the natural pasturage, special crops for honey alone are not profitable, but where other utilities besides that of honey yield can be combined with it, there is some advantage to be gained.

Filbert Bushes.—Useful for wind breaks and for their nuts, yield pollen in February and March.

Rape.—Can be grown successfully in the North for pasturage, for green manuring, or for seed, and when permitted to blossom yields considerable pollen and honey. Winter varieties are sown late in the summer or early in the autumn, and blossom in April or May following. This early yield forms an excellent stimulus to brood rearing. Summer or bird rape, grown chiefly for its seed, blossoms about a month after sowing. It does best during the cooler months of the growing season.

Russian or Hairy Vetch.—Is a hardy leguminous plant of great value for forage and use in green manuring. The blossoms appear early in the season, and, where there is any lack in early pollen, especially in northern and cool regions, this vetch will be found of great value to the bees.

Fruit Blossoms.—Apricot, peach, pear, plum, cherry, apple, currant, and gooseberry, yield pollen and honey in abundance during April or May; strawberry and blackberry are sometimes visited freely by bees, but are generally far less important than the others mentioned. Colonies that have wintered well often gather during apple bloom 12 to 15 pounds of surplus honey of fine quality. The raspberry secretes a large amount of nectar of superb quality, and coming in May or June, thus later than the other fruit blossoms and when the colonies are stronger and the weather is more settled, full advantage can nearly always be taken of this yield. Grape and persimmon blossom also in June; the latter is an excellent source. In subtropical portions of the country orange and lemon trees yield fine honey in March and April, and the cultivation of the banana has added a profuse honey yielder which puts forth successive blossoms all through the summer months.

Locust, Tulip Tree ("poplar," or whitewood), and *Horse-Chestnut.*—Useful for shade, ornament, and timber, are all fine honey producers in May. The locust yields light-colored, clear honey of fine quality, the others amber-colored honey of good body and fair flavor.

Clovers.—Crimson, blossoming in April or May, yields fine, light-colored honey; white, alsike, and mammoth or medium, blossoming in May, June, and July, give honey of excellent quality and rich yellow color.

Mustard.—Grown for seed flowers from June to August. The honey is somewhat acrid and crystallizes soon, yet the plant, where abundant, is of much importance to the bees and the bee keeper in case other forage is scant at the time.

Asparagus.—Blossoms are much visited by bees in June and July.

Esparcet, or *Sainfoin.*—Yields in May and June fine honey, almost as clear as spring water. It is a perennial leguminous plant, rather hardy, an excellent forage crop, and particularly valuable for milch cows. It succeeds best on a limestone soil or when lime is used as a fertilizer, and is itself an excellent green manure for soils deficient in nitrogen and phosphoric acid.

Sulla, or Sulla Clover.—A perennial plant, closely related to esparcet or sainfoin, succeeds, like the latter, best upon limestone soil or when fertilized with lime. It yields a splendid quality of honey from beautiful pink blossoms, which continue during May and June. The plant is an excellent soil fertilizer and of great value in connection with the feeding of stock, particularly dairy animals. It is, however, much less hardy than esparcet, and success with it can therefore hardly be looked for above the latitude of North Carolina and Arkansas. When the qualities and requirements of this plant were brought by the writer to the notice of a prominent scientific agriculturist of the South, this gentleman suggested as very probable that the black belt of Alabama, Mississippi, Louisiana, and Texas would be well adapted to it, the lands of this region being exceedingly strong in lime. In portions of Southern Europe sulla clover is a most important forage crop for farm stock as well as for honey bees.

Serradella.—Is an annual leguminous plant which will grow on sandy land, and which yields, besides good forage, clear honey of good quality in June and July.

Chestnut.—Valuable for timber, ornament, shade, and nuts, yields honey and pollen in June or July.

Linden, Sourwood, and Catalpa.—Fine shade, ornamental, and timber trees, yield great quantities of first quality honey in June and July.

Cotton.—In the South cotton blossoms, appearing as they do in succession during the whole summer, often yield considerable honey. It would appear, however, that when the plants are very rank in growth the blossoms—being correspondently large—are too deep for the bees to reach the nectar.

Chicory.—Raised for salad and for its roots, is, whenever permitted to blossom, eagerly visited for honey in July and August.

Sweet, Medicinal, and Pot Herbs.—Such as marjoram, savory, lavender, catnip, balm, sage, thyme, etc., when allowed to blossom, nearly all yield honey in June, July, or August. Where fields of them are grown for the seed the honey yield may be considerable from this source.

Alfalfa.—Furnishes in the West a large amount of very fine honey during June and July. Its importance there as a forage crop is well known, but how far eastward its cultivation may be profitably extended is still a question, and even should it prove of value in the East as a forage plant, its honey-producing qualities there would be still uncertain.

Parsnips.—When left for seed, blossom freely from June to August, inclusive, and are much frequented by honey bees.

Peppermint.—Raised for its foliage, from which oil is distilled, is most frequently cut before the bees derive much benefit from it, but whenever allowed to blossom it is eagerly sought after by them, and yields honey freely during July and August.

Bokhara, or Sweet Clover.—Is in some sections of the country considered a valuable forage crop. Animals can be taught to like it, and it is very valuable as a restorer of exhausted lime soils, while in regions lacking in bee pasturage during the summer months it is a very important addition. It withstands drought remarkably well and yields a large quantity of fine honey.

Cucumber, Squash, Pumpkin and Melon.—Blossoms furnish honey and some pollen to the bees in July and August.

Eucalypti.—Valuable for their timber and as ornaments to lawn and roadside, are quick-growing trees adapted to the southern portions of the United States. They yield much honey between July and October.

Carob Tree.—The cultivation of which has been commenced in the Southwest, is an excellent honey yielder in late summer. It is an ornamental tree and gives, in addition to honey, another valuable product—the carob bean of commerce.

Sacaline.—A forage and ornamental plant of recent introduction, is a great favorite with bees. It blossoms profusely during August, is a hardy perennial, and thrives in wet and also fairly in dry situations, withstanding the ordinary summer drought of the Eastern states because of its deeply penetrating roots.

Buckwheat.—Is an important honey and pollen producer. Its blossoms appear about four weeks after the seed is sown, hence it may be made to fill in a summer dearth of honey plants.

How to Obtain Surplus Honey and Wax

Good wintering, followed by careful conservation of the natural warmth of the colony, the presence of a prolific queen—preferably a young one—with abundant stores for brood rearing, are, together with the prevention, in so far as possible, of swarming, the prime conditions necessary to bring a colony of bees to the chief honey flow in shape to enable it to take full advantage of the harvest.

Extracted Honey

To secure extracted honey, the requisite number of combs may be in one long hive, or in stories one above another. If numerous sets of combs are at hand, or if it is desirable to have others built, additional stories are put on as fast as the combs already occupied by the bees are filled. Before removing the filled combs time should be allowed the bees to ripen and cap the honey; hence enough combs are necessary to give the bees storage room while they are capping others. The honey in combs that are quite or nearly sealed over may be considered sufficiently ripened to be removed from the hive.

It should also be taken promptly, in order to keep the various grades or kinds separate.

The cells are uncapped by means of a sharp knife, made especially for this purpose (Fig. 6), and the combs are then made to revolve rapidly in the honey extractor. The centrifugal force exerted on the honey throws it out, leaving the comb cells uninjured, or so slightly injured that they are wholly repaired within an hour or so after the return of the comb to the hive. The chief advantages of this method of harvesting over that of crushing the combs are at once apparent when it is known that each pound of comb saved represents several pounds of honey (consumed in its construction), and may, with care be used over almost indefinitely in securing surplus honey. Furthermore, extracted honey is of much finer quality than that obtained by crushing the combs and straining out the liquid part, since it is free from crushed bees, larvae, pollen or "bee bread," etc., which not only render strained honey dark and strong in flavor, but also make it liable to fermentation and souring.

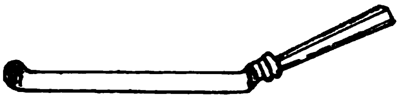

Fig. 6. Quinby Uncapping Knife.

The extracted honey is run into open buckets or tanks and left, covered with cheese cloth, to stand a week or so in a dry, warm room not frequented by ants. It should be skimmed each day until perfectly clear, and is then ready to be put into cans or barrels for marketing, or to be stored in a dry place.

The surplus combs are to be removed at the close of the season and hung an inch or so apart on racks placed in a dry, airy room, where no artificial heat is felt. Moth larvae are not likely to trouble them until the following spring, but upon the appearance of milder weather their ravages will begin, and if the combs cannot be placed under the care of the bees at once they must be fumigated with burning sulphur or with bisulphid of carbon.

Comb Honey

The main difference to be observed in preparing colonies for the production of comb honey, instead of extracted, is in the adjustment of the brood apartment at the time the supers are added. After the colony has been bred up to the greatest possible strength, the brood apartment should be so regulated in size, when the honey flow begins and the supers are added, as to crowd many of the bees out and into the supers placed above.

On each hive a super is placed holding 24 to 48 sections, each section supplied with a strip or a full sheet of very thin foundation. It is best not to give too much space at once, as considerable warmth is necessary to enable the bees to draw out foundation or to build comb. A single set of sections is usually sufficient at a time. When the honey is designed for home use or for a local market, half-depth frames are sometimes used, the same as those often used above the brood nests when colonies are run for extracted honey, but for the general market pound sections are better adapted.

It is the practice of many to have nice white comb partially drawn out before the main honey flow begins, or even the season before, feeding the colonies, if necessary, to secure this; and, when the honey yield begins, to supply sets of sections with these combs having cells deep enough for the bees to begin storing in as soon as any honey is collected. Earlier work in the sections is thus secured, and this, as is well known, is an important point in the prevention of swarming. Samuel Simmins, of England, has long contended for this use of partially drawn combs, and though it forms a feature of his system for the prevention of swarming it has been too often overlooked. Comb foundation is now manufactured with extra thin septum or base and with the beginnings of the cells marked out by somewhat thicker walls which the bees immediately thin down, using the extra wax in deepening the cells. This is not artificial comb, but a thin sheet of wax having the bases of the cells outlined on it. Complete artificial combs have never been used in a commercial way, although there exists a widespread belief to this effect, which is founded on extravagant claims that have appeared from time to time in newspaper articles.

If the brood apartment has been much contracted when the supers were added, the queen may go into the sections and deposit eggs unless prevented by the insertion of a queen excluder (Fig. 7). This, merely a sheet of zinc with perforations which permit workers, but not the queen, to pass, is placed between the brood apartment and the supers. The great inconvenience of having brood in some of the sections is thereby prevented. When the honey in the sections has been nearly capped over, the super may be lifted up and another added between it and the brood apartment. Or, should the strength of the colony not be sufficient, or the harvest not abundant enough to warrant the giving of so much space, the sections which are completely finished may be removed and the partly finished ones used as "bait sections" to encourage work in another set of sections on this hive or in new supers elsewhere. The objections to the removal of sections one by one, and brushing the bees from them, are (1) the time it takes, and (2) the danger that the bees when disturbed, and especially if smoked, will bite open the capping and begin the removal of the honey, thus injuring the appearance of the completed sections.

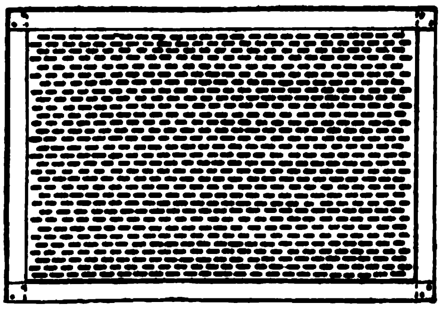

Fig. 7. Perforated Zinc Queen Excluder.

A recent valuable invention, the bee escape, when placed between the super and the brood nest, permits the bees then above the escape to go down into the brood apartment, but does not permit their re-entering the super. If inserted 12 to 24 hours before the sections are to be removed, the latter will be found free from bees at the time of removal, provided all brood has been kept out of the supers.

Grading and Shipping Comb Honey

Before marketing the honey it should be carefully graded, and all propolis ("bee-glue"), if there be any, scraped from the edges of the sections. In grading for the city markets the following rules are, in the main, observed. They were adopted by the North American Bee Keepers' Association at its twenty-third annual convention, held in Washington, D. C., in December, 1892, and are copied from the official report of that meeting:

Fancy.—All sections to be well filled; combs straight, of even thickness, and firmly attached to all four sides; both wood and comb unsoiled by travel stain or otherwise; all cells sealed except the row of cells next to the wood.

No. 1.—All sections well filled, but with combs crooked or uneven, detached at the bottom, or with but few cells unsealed; both wood and comb unsoiled by travel stain or otherwise.

In addition to the above, honey is to be classified, according to color, into light, amber, and dark. For instance, there will be "fancy light," "fancy amber," and "fancy dark," "No. 1 light," "No. 1 amber," and "No. 1 dark."

The sections, after grading and scraping, are to be placed in clean shipping cases having glass in one or both ends. Several of these may be placed in a single crate for shipment. To prevent breaking down of the combs it is best to put straw in the bottom of the crate for the shipping cases to rest on, and the crates should be so placed as to keep the combs in a perpendicular position. The crates are also likely to be kept right side up if convenient handles are attached to the sides—preferably strips with the ends projecting beyond the corners. Care in handling will generally be given if the glass in the shipping cases shows.

Production of Wax

No method has yet been brought forward which will enable one, at the present relative prices of honey and wax, to turn the whole working force of the bees, or even the greater part of it, into the production of wax instead of honey; in fact, the small amount of wax produced incidentally in apiaries managed for extracted or for section honey is usually turned into honey the following season; that is, it is made into comb foundation, which is then employed in the same hives to increase their yield of marketable honey. It is even the case that in most apiaries managed on approved modern methods more pounds of foundation are employed than wax produced; hence less progressive bee keepers — those who adhere to the use of box hives and who can not therefore utilize comb foundation—are called upon for their wax product. As each pound of wax represents several pounds of honey, all cappings removed when preparing combs for the extractor, all scrapings and trimmings and bits of drone comb, are to be saved and rendered into wax. This is best done in the solar wax extractor (Fig. 8), the essential parts of which are a metal tank with wire-cloth strainer and a glass cover, the latter generally made double. The bottom of the metal tank is strewn with pieces of comb, the glass cover adjusted, and the whole exposed to the direct rays of the sun. A superior quality of wax filters through the strainer.

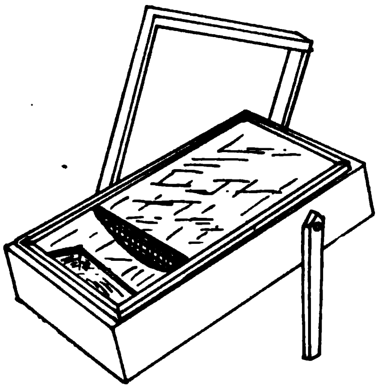

Fig. 8. Solar Wax Extractor.

The Wintering of Bees

How to bring bees successfully through the winter in the colder portions of the United States is a problem which gives anxiety to all who are about to attempt it for the first time in those sections, and even many who have kept bees for years still find it their greatest difficulty. A queen may die and the colony dwindle away. But care as to ventilation, dampness, age of the bees, etc., will usually insure a successful wintering. Out-of-door wintering is to be preferred where the climate is not too severe.

General Considerations

Whatever method be followed in wintering, certain conditions regarding the colony itself are plainly essential: First, it should have a good queen; second, a fair-sized cluster of healthy bees, neither too old nor too young; third, a plentiful supply of good food. The first of these conditions may be counted as fulfilled if the queen at the head of the colony is not more than two years old, is still active, and has always kept her colony populous; yet a younger queen—even one of the current season's rearing, and thus but a few weeks or months old—is, if raised under favorable conditions, much to be preferred. The second point is met if brood rearing has been continued without serious interruption during the latter part of the summer and the cluster of bees occupies, on a cool day in autumn, six to eight or more spaces between the combs, or forms a compact cluster eight or ten inches in diameter. Young bees, if not well protected by older ones, succumb readily to the cold, while quite old bees die early in the spring, and others, which emerged late in the summer or autumn preceding are needed to replace them. The third essential—good food—is secured if the hive is liberally supplied with well-ripened honey from any source whatever, or with fairly thick syrup, made from white cane sugar, which was fed early enough to enable the bees to seal it over before they ceased flying. The syrup is prepared by dissolving three pounds of granulated sugar in one quart of boiling water and adding to this one pound of pure extracted honey. Twenty to 25 pounds for outdoor wintering in the South, up to 30 or 40 pounds in the North, when wintered outside with but slight protection—or, if wintered indoors, about 20 pounds—may be considered a fair supply of winter food.

Indoor Wintering

A dry, dark cellar or special repository built in a sidehill or with double, filled walls, like those of an icehouse, may be utilized for wintering bees in extremely cold climates. It should be so built that a temperature of 42 to 45 degrees Fahrenheit (the air being fairly dry in the cellar) can be maintained during the greater part of the winter. To this end it should be well drained, furnished with adjustable ventilators, and covered all over with earth, except the entrance, where close-fitting doors, preferably three of them, should open in succession, so as to separate the main room from the outside by a double entry way. The colonies, supplied with good queens, plenty of bees, 20 to 25 pounds of stores each, and with chaff cushions placed over the frames, are carried in shortly before snow and severe freezing weather come.

Any repository which is damp or one whose temperature falls below freezing or remains long below 38 degrees Fahrenheit is not a suitable place in which to winter bees. When in repositories, the bees have no opportunity for a cleansing flight, nor do they, when the temperature rises outside, always warm up sufficiently to enable the cluster to move from combs from which the stores have been exhausted to full ones, hence in a cold repository they may possibly starve with plenty of food in the hive. As a rule, colonies would be better off out of doors on their summer stands than in such places.

Outdoor Wintering

Cold and dampness are the great winter enemies of bee life. A single bee can withstand very little cold, but a good cluster, if all other conditions are favorable, can defy the most rigorous winters of our coldest states. But if not thoroughly dry, even a moderate degree of cold is always injurious, if not absolutely fatal. Dampness in winter is therefore the most dangerous element with which the bee keeper has to contend. The matter would, of course, be quite simple if only that dampness which might come from the outside were to be considered, but when the air of the hive, somewhat warmed by the bees and more or less charged with the moisture of respiration, comes in contact with hive walls or comb surfaces made cold by outside air, condensation takes place, and the moisture trickles over the cold surfaces and cluster of bees, saturating the air about them or even drenching them, unless by forming a very compact cluster they are able to prevent it from penetrating, or by greater activity to raise the temperature sufficiently to evaporate the surplus moisture, or at least that portion near them. But this greater activity is, of course, at the expense of muscular power and requires the consumption of nitrogenous as well as carbonaceous food. Increased cold or its long continuance greatly aggravates conditions.

Nature has provided that the accumulation of waste products in the body of the bee during its winter confinement should be small under normal conditions, but unusual consumption of food, especially of a highly nitrogenous nature like pollen, necessitates a cleansing flight, or diarrheal difficulties ensue, combs and hives are soiled, the air of the hive becomes polluted, and at last the individual bees become too weak to generate proper warmth or drive off the surplus moisture which then invades the cluster and brings death to the colony; or, what is more frequently the case, a cold snap destroys the last remnant of the colony, which has been reduced by constant loss of bees impelled by disease to leave the cluster or even to venture out for a cleansing flight when snows and great cold prevail.

The problem then is: *To retain the warmth generated by the bees, which is necessary to their well-being, and at the same time to prevent the accumulation of moisture in the hive.* A simple opening at the top of the hive would permit much of the moisture to pass off, but of course heat would escape with it and a draft would be produced. Absorbent material about the cluster creates, without free ventilation, damp surroundings, and again the temperature is lowered. It is only necessary, however, to surround the bees with sufficient material to protect them fully against the greatest cold likely to occur, and to take care also that this enveloping material is of such a nature and so disposed as to permit the free passage of the moisture which would otherwise collect in the interior of the hive, and to permit the escape into the surrounding atmosphere of such moisture as enters this material from within. This packing should also be fully protected from outside moisture.

South of Virginia, Kentucky, and Kansas single-walled hives may be employed in most localities with good success in outdoor wintering. On the approach of the cool or the rainy season a close-fitting quilt should be laid over the frames and several folded newspapers pressed down on this, or a cushion filled with dry chaff or some other soft material may be used instead of paper. The cover or roof should be absolutely rainproof, yet between this cover and the cushion or papers should be several inches of space with free circulation of air. In order to permit this ventilation above the top packing, the cover should not rest upon the cap or upper story all of the way around, or if it does, an auger hole in each end, protected by wire cloth against the entrance of mice, should give free passage to the air. In the more northern portion of the section referred to some further protection is advisable, and is really necessary in the mountainous parts of the same territory if the best results are to be obtained. Farther north, and especially in the cold Northwest, much greater protection becomes an absolute necessity. Quilts with newspapers or thin packing above do not alone suffice. The side walls of the hive may be made of pressed straw. These, with top packing, if kept dry outside, are excellent for outdoor wintering, even in climates so cold that ordinary wooden hives do not afford sufficient protection.

In the severest climates, however, still greater protection on all sides of the colony is needed, and packing with chaff or other soft material is decidedly the best plan. The thickness of this surrounding packing should be from two inches to eight or ten inches for single colonies, according to the severity of the climate, but if four or more colonies are grouped for the winter, so as to make the natural warmth generated mutually advantageous, somewhat less packing will be sufficient. A most important point is to have the soft warmth-retaining packing come in close contact with the edges of the combs, and above all *not to have a hive wall, either thick or thin, between this material and the bees.* A good plan is to construct an open framework or skeleton hive of laths, cover it with sacking, or, preferably, some less fuzzy cloth which the bees will not gnaw, and after placing it in an outer wooden case large enough every way to admit of the necessary packing about the colony, to fill in on all sides with some dry, porous material. If the frames are shallow, like the Langstroth, it is better to construct the inner case so as to place them on end, and thus give a deeper comb for the winter. Layers of newspapers may come next outside the cloth covering of the framework. Wheat chaff answers well to complete the packing. Wool is to be preferred, but is of course too expensive unless a waste product. Ground cork, waste flax, hemp, sawdust, etc., in fact, any fine porous material, if thoroughly dry, may be used.

A board passageway three or four inches wide and three-eighths of an inch high should connect this inner apartment and the flight hole of the outer case, thus affording an exit for the bees whenever the weather may permit them to fly. When these preparations have been completed, the hive is ready for the combs, which, with adhering bees, are taken from the summer hive and inserted in the winter hive. A quilt is then laid on the frames and the top packing put on. This, for convenience, may be held in a cloth-bottomed tray. It is quite important as already mentioned, that air be allowed to circulate freely above the packing. The outside case must be quite rainproof or else wholly protected from the rain by a roof.

All other necessary conditions having been complied with shortly after the gathering season closed, the combs may be lifted from the summer hives and placed in these specially arranged winter cases before cold weather wholly stops the bees from flying out. Thus prepared for the winter the colonies will need but slight attention from October until March, or, in the North, even later, and the losses will be limited to the small percentage of cases due to failure of apparently good queens.

The Risk of Loss Through Disease and Enemies

Winter losses through disease superinduced by unfavorable surroundings which it is within the power of the bee keeper to avoid have already been considered. But one other very serious disease has been widespread.

Foul Brood or Bacillus of the Hive

This is a highly contagious affection which, as it mainly affects the developing brood in the cells, is commonly known as "foul brood." It is due to a microbe (*Bacillus alvei*) whose spores are easily transported from hive to hive by the bees themselves, by the operator, in honey, or in combs changed from one hive to another. Once established in an apiary, it usually spreads, unless speedily and energetically checked, until all of the colonies in the neighborhood are ruined and even exterminated. The most apparent symptoms are the turning black of larvae in open cells, many sealed cells with sunken caps, frequently broken in and containing dead larvae or pupae in a putrid condition, brown or coffee-colored, jelly-like or ropy in consistency, and giving off an offensive odor. The disease, though known to exist in nearly all countries, can hardly be said to be common. The writer, in an experience of over 30 years in bee keeping in several states of the Union, as well as in a number of foreign countries, has met the disease but rarely, and has had but one experience with it in his own apiary, it having been in this instance brought in by a neighbor who purchased bees at a distance. It was easily cured, without great loss. Thus the beginner's risks of disaster in this direction are, if he be forewarned, comparatively small. He may, furthermore, gain assurance from the fact that, should the disease invade his apiary, prompt and intelligent action will prevent serious loss.

The following is the treatment for a colony which still has sufficient strength of numbers to be worth saving: The bees are to be shaken from their combs just at nightfall into an empty box, which is to be removed at once to a cool, dark place. They are to be confined to the box, but it must be well ventilated through openings covered with wire cloth. During the first 48 hours no food should be given to them, and during the second 48 hours only a small amount of medicated syrup—a half pint daily for a small colony to a pint for a strong one. This food is prepared by adding one part of pure carbolic acid or phenol to 600 or 700 parts of sugar syrup or honey. At the end of the fourth day the bees are to be shaken into a clean hive supplied with starters of comb foundation. This hive is to be placed outside on a stand some distance from all other colonies, and moderate feeding with medicated syrup or honey should be continued for a few days thereafter.

The combs of diseased colonies which contain brood may be assembled over a single one of these colonies, or, if the amount of brood be too great for one colony to care for, over several such diseased colonies, until the young bees have emerged. All of the honey is then to be extracted. While it is wholesome as food, it should not be offered for sale, lest some of it be used in feeding bees or be inadvertently exposed where foraging bees might find it and carry to their hives the germs of this disease, harmless to other creatures but so fatal to bee life. A good use for this honey is to employ it in making vinegar.

If the honey containing the germs is to be used for feeding bees, it is to be diluted with half its own quantity, by measure, of water and kept at the boiling point for three hours in a water bath—a vessel within another containing water.

The combs from which the honey has been extracted, as well as all of the pieces built by the bees during their four days' confinement, may be melted into wax, by thorough boiling in soft water. This wax should be kept liquid for 48 hours or longer, to allow all impurities to settle. These will include the foul brood spores, which may then be removed with the impure wax by scraping or cutting away the bottom of the cake. These scrapings should be burned. The same disposition had better be made of the frames from which the combs containing germs were removed.

In all of this work the utmost care should be exercised to avoid the dripping of honey about the apiary or the exposure of implements, receptacles, or combs smeared with or containing honey from the diseased colonies. The old hive and all utensils used about the diseased colony should be disinfected by washing in a solution of corrosive sublimate. If it be found that the diseased colonies are weak in numbers and seem, therefore, individually hardly worth saving, several colonies may be smoked and shaken together into the same box to make a single strong colony, the best queen of the lot having been selected and caged in the box in such a way that the workers can release her within a few hours by eating through candy.

Bee Paralysis

Among other diseases of a bacterial nature paralysis is most noticeable, although not to be dreaded as foul brood. It affects the adult bees only, producing a paralyzed condition of their members and a swelling up of their bodies. The source from which the bees obtain the original infection is unknown, but, once in the apiary, it is spread mainly by the entrance of affected workers into healthy colonies, and probably also by the visits which bees from healthy colonies make to the diseased ones, the latter often being so weakened in numbers as to be unable to protect their stores from healthy bees out on robbing expeditions.

Ordinary paralysis may generally be cured by strewing powdered sulphur over the combs, bees, and along the top bars of the frames, the precaution first having been taken of removing all unsealed brood. This brood would be killed by the application of sulphur, but as there is no danger whatever of spreading the disease by the transfer of brood or honey from one hive to another, provided absolutely every one of the adult bees has first been shaken or brushed from the combs, the latter may be given to healthy colonies which need strengthening.

Another simple plan for getting rid of the disease and yet utilizing the available strength of the affected colonies is to close their hives at night and move them a mile or more, locating them, if possible, outside of the range of other bees. As the brood in these colonies remains healthy all that is sealed or even well advanced in the larval stage may have the bees shaken from it and be distributed among the remaining colonies of the apiary. The bees of the diseased colonies thus become rapidly reduced in numbers, and several of the colonies themselves may soon be combined, the best queen being selected to continue egg laying. Eventually the diseased apiary becomes, by the removal of the developing brood and the death of the old bees, reduced to nothing. None of the queens should be saved nor should any of the adult workers be returned to the healthy apiary.

A combination of the sulphur cure with the last plan mentioned—that of getting rid of the disease through the removal of brood combs from affected colonies—is really, all in all, the best procedure. When a fairly strong colony has been made up by shaking the adult bees of two or more together and this removed to an isolated locality, the application of sulphur may be made before any brood has been started. It is well, also, to replace the queen with a vigorous one from stock entirely unrelated to the diseased bees. Should any signs of the disease reappear, constant removal of the brood should be followed, as mentioned in the preceding paragraph.

Other bacterial diseases, though existing, have developed only very locally or have been too limited in the amount of injury inflicted to require special mention here.

Insect and Other Enemies

The bee or wax moth (*Galleria mellonella* Linn.) is regarded by those unfamiliar with modern methods in bee keeping as a very serious enemy to success in this work. It was frequently such when only the common black bee was kept and the old way of managing, or rather of trusting to luck, was followed. But with the better races now introduced and with improved hives and methods, and especially with the care that is now given to have no colonies queenless long at a time, the wax-moth larvae are no longer regarded with great concern.

Spiders, toads, and lizards destroy, in addition to many injurious insects, also some bees, and should be tolerated in the vegetable garden rather than in the apiary.

Swallows, kingbirds or bee martins, mice, skunks, and bears only occasionally commit depredations in the apiary.

Properly constructed hives enable the bees to limit in a great measure the injury which these various enemies might inflict, and the avoidance of overswarming, with care to insure the constant presence of a prolific queen and a supply of food suited to the needs of the colony at the time, will keep it populous and therefore in shape to repel attacks or to make good most of the unavoidable losses.

Robber Bees

Robbing is sometimes a more serious matter, although a little careful attention just at the right time on the part of the bee keeper would avoid all serious trouble on this score. When bees find nothing to gather during weather when they can still fly out they are easily tempted to appropriate the stores of weaker colonies. Exposure of combs of honey at such times may even occasion a combined attack upon a good colony otherwise quite able to take care of itself. It is then that the greatest destruction ensues, for such a colony will defend itself vigorously, and a pitched battle, with perhaps 50,000 or 60,000 Amazons on either side, leaves the ground literally strewn with dead and dying.

If the invaders conquer, every drop of honey is taken from the few vanquished that are likely to be still alive; and in turn the despoilers invariably fight among themselves as to the possession of the booty. When the robbing takes place during the absence of the owner, the condition of the robbed colony may not attract immediate attention, and during warm weather moth larvae gain full possession of the combs within a few days. When this condition is observed, the whole damage is very likely to be attributed to the moth larvae. Colonies that have been left queenless for some time, and those weakened by disease or by overswarming, are especial marks for such attacks. Of course these defects should be remedied whenever observed, but meanwhile, if legitimate field work is likely to be interrupted, every colony should be assisted in protecting itself against assault by having its hive made secure and the entrance such a narrow pass as to enable a few workers to repel attack there.

Should robbers get well started before being observed, the entrance of the hive should be narrowed at once, and wet grass or weeds may be thrown loosely over it, or a pane of glass may be stood against the front of the hive in a slanting manner to confuse the intruders. In extreme cases the attacked colonies may be removed to a cellar for a few days, plenty of ventilation being given during confinement, and a new location, apart from other colonies, selected, on which they are to be placed just at nightfall; or, instead of putting them in the cellar, they may be taken a mile or more away and returned only when the danger has passed. With these precautions, little loss is to be feared on this score.

In general, the intelligent owner who gives careful attention to certain important points in bee management finds that he very rarely has disease to contend with, and that the reduction of profits through the depredations of bee enemies is not, in most parts of the Union, a serious discouragement. Altogether it seems to the writer that the risks in these directions are even less in bee keeping than those usually met in the keeping of other animals, which, like bees, are legitimately made to contribute to the wealth of the individual and of the nation.

Journals Treating of Apiculture

As a matter of general information, the following list of journals relating to apiculture is given. It comprises all those published in this country at the present time.

The American Bee Journal, Chicago, Ill.
Gleanings in Bee Culture, Medina, Ohio.
The Bee Keepers' Review, Flint, Mich.
The American Bee Keeper, Falconer, N. Y.
The Progressive Bee Keeper, Higginsville, Mo.
Western Bee Journal, Kingsburg, Cal.
The Rural Bee Keeper, River Falls, Wis.

Beets

The beet is used as a garden vegetable, for feeding stock, and making sugar. There are about 40 varieties of the beet in cultivation in the United States ranging in color from deep red to white.

The Sugar Beet

The cultivation of the sugar beet in the United States, for the manufacture of sugar, is one of the important industries. The variety grown for this purpose, is generally the *Beta maritima*. In the earlier manufacture of beet sugar in Europe, the beet only yielded about 4.5 per cent sugar for the red variety, and 6.2 per cent for the white. At the present time, the varieties have been so improved by the selection of seed, by manuring and the careful selection of soil, that they now yield from 10 per cent, to 13 per cent sugar. In some parts of the country, the average weight of beets per acre, has been as high as 26 tons, and the average percentage of sugar in the juice, as high as 16 per cent. After the sugar is extracted, it is common to use the pulp as food for stock.

Garden Beets

Among the varieties of garden beets are the following:

Eclipse.—A very early, dark-red, turnip shaped variety, of good quality, a favorite with market gardeners, may be planted early in spring, and at almost any time during the later season.

Early Turnip Beet, Baastions.—A valuable early variety, sweet, tender, and one of the best for early and late planting.

Egyptian.—A good variety for early spring sowing.

Dewing's Improved Blood Turnip Beet.—A first class beet, for winter or summer use.

Stock Beets

These varieties are very prolific, yield heavily per acre, and require a rich deep soil.

Planting

The seed may be sown in hot beds for early planting, or it may be sown in the open ground and the plants removed to the field or garden; or it may be sown in the rows where the beets are to grow. In this case it should be sown in sufficient quantities, so that the plants may be thinned to the proper distance apart. In the garden, the seeds are generally sown in drills, about 15 inches apart, and the plants thinned to about 8 inches. The stock beets and sugar beets, growing to much larger size, must be planted farther apart. The ground should be rich and loose, because the beet is a heavy feeder, and requires a fertile soil. In the arid regions where irrigation is practiced, where the alkali leaches from the soil and is deposited on the low lands, it has been demonstrated that sugar beets and stock beets will stand a much larger content of alkali, than most other crops; therefore lands that have been abandoned for general farming, because they were too strong in alkali to grow crops successfully, have proven to be valuable for the growing of sugar beets.

Varieties

Eclipse, Edmund Blood Turnip, Crosby's Egyptian, Blood Red, Dreer Excelsior.

GRANVILLE LOWTHER

Sugar Beet Growing Under Irrigation

C. O. TOWNSEND

Pathologist, Cotton and Truck Disease and Sugar Plant Investigations

Introduction

The present sugar beet belt of the United States, that is, the area within which the soil and climatic conditions admit of the successful production of sugar beets for the manufacture of sugar, extends entirely across the northern portion of this country. The present southern boundary of this area is a somewhat indefinite and irregular line that may be said to extend from Virginia on the east to the southern part of California on the west. Efforts are being made to extend this line farther south, thereby increasing the productive sugar beet area. This can undoubtedly be accomplished with an increased knowledge of the requirement of the sugar beet plant combined with its wide range of adaptability. As it is at present this belt is capable of maintaining hundreds of sugar beet mills, the output of which would supply this country with the millions of pounds of sugar required for home consumption. A study of the great variety of soil and climatic conditions under which sugar beets thrive illustrates and emphasizes the wonderful adaptability of this remarkable plant to the wide range of conditions under which it may profitably be produced.

This article will be confined to a consideration of the conditions and cultural methods employed in those areas where there is an insufficient precipitation for the profitable production of sugar beets, namely, the central, western and southwestern portions of the United States.

Selection of Soil

In the irrigated portion of the sugar beet belt there is a great variety of soils, varying from the distinctly sandy type through the sandy and clay loams, the silt, and volcanic ash to the heavy black adobe. In the selection of soil for sugar beet culture it is safe to say that any of the soil types that are capable of producing good crops of other kinds will produce satisfactory beets.

The principal factors to be considered are the physical condition of the soil, the way in which it has been previously handled, and the climatic conditions. Much more depends upon these factors than upon the kind or type of soil to be used. The physical condition of the soil depends to a considerable extent upon the previous crops and the way in which the soil has been handled. The soil should be well supplied with humus, not only to insure its fertility but to improve its water-holding capacity. The previous cropping should have been such that the ground is in good tilth and reasonably free from pests that are capable of injuring sugar beets. The soil should be well drained, either naturally or artificially, in order to prevent water-logging, and the ground should be kept sweet and at the same time free from an excess of alkali. Most of the western soils are well supplied with lime, but an occasional application will in some cases be found beneficial.

Extremely sandy soils should not be selected for sugar beet growing, especially in localities where high winds prevail in the spring. The adobe and silty soils should be handled with considerable care to prevent baking and crusting. It is generally assumed that new sod ground is not suitable for beets, but experience has shown that good results may be obtained from our western virgin soils. If such ground is to be planted to beets the sod should be broken in the summer, the ground fall plowed, worked down, and kept moist so that the sod will rot.

The kind and location of the subsoil are always important factors. In some cases the subsoil is very porous. This condition can be relieved to some extent by increasing the humus supply in the soil and by giving special attention to firming the seed and root beds in order that their water-holding capacity may be increased. If the subsoil is extremely porous and deep, it would not be advisable to use the soil for beet culture.

If the hardpan is close to the surface, so that there is not sufficient depth of soil to produce sugar beets, the field should not be used. If a good soil to the depth of 18 inches or more covers the hardpan, it will be safe.

Climatic Conditions

The principal climatic factors which have a direct bearing upon sugar beet culture are temperature, precipitation, and winds. A study of the most successful sugar beet localities of the world leads to the conclusion that beets of the best quality can not be grown where the average temperature for the season when the beets are being grown is much above 70 degrees Fahrenheit.

Low temperatures are most likely to be injurious to sugar beets when the plantlets are just breaking through the ground, but after the roots are established in the soil they rapidly become hardy and resistant to frost to a marked degree. A killing frost when the beets are coming up often necessitates the expense and labor of replanting.

The great danger from low temperatures at the end of the growing season is that the beets may be frozen in the ground. To avoid this danger and the consequent loss that might result from such a condition it is advisable to get the beets out of the ground as soon as possible after they are ripe and to cover them to avoid freezing or drying. Apparently beet roots are not injured for sugar-making purposes by freezing, provided that they freeze and remain frozen until they are put through the mill, but alternate freezing and thawing causes them to decay and blacken, so that their value for sugar making is materially decreased.

The practice that prevails in some localities of letting the natural moisture escape from the soil, with the idea that more water can be applied when it is needed, is most pernicious and should not be followed. The moisture that falls upon the ground in the form of precipitation and is received and retained by the soil acts upon the plant foods day after day and week after week and accomplishes most for plant growth. There is a feeling of safety in having an unlimited supply of water for irrigation purposes, but it should be remembered that irrigation costs money and labor; precipitation is nature's gift.

Winds have been briefly mentioned in connection with soil selection for sugar beets, but they have a still wider bearing upon crop conditions.

The blowing of the soil and the excessive evaporation may often be reduced to the point of successful crop production by keeping the surface of the ground covered with a lump mulch. The mulch retards the evaporation, while its lumpy condition reduces the shifting of the soil. The cutting action of the shifting sand may be controlled by planting the beet rows at right angles to the direction of the prevailing winds when practicable and by attaching irrigating shovels to the drills, so that the ridges capable of protecting the young plants will be thrown up between the rows at planting time.

Plowing

The time, the depth, and the kind of plowing done and the condition of the ground at the time of plowing are all important factors in preparing the soil for sugar beets. As a rule, the most satisfactory time to plow for beets is in the fall, for the reason that fall-plowed ground is in better condition to receive the winter moisture and consequently to respond to the freezing and thawing action which tends to put the soil in the best physical and chemical condition for plant production.

In the irrigated sections plowing should never be left until spring if it can possibly be done earlier. In the first place the rush of spring work is not favorable to the best kind of plowing, but more important is the fact that stirring the ground to such a depth so close to planting time promotes evaporation and often the entire seed and root beds are comparatively dry before the seed is planted.

If done in the fall, there is very little danger of plowing too deep. Other things being equal, plowing to a depth of 10 to 14 inches or more will give the best results. Subsoil plowing is not generally practiced, and in cases where deep plowing is done and the soil below the plowed area is not too hard for the beet roots to penetrate it readily subsoiling would not pay for the labor and money expended. Where for any reason the plowing can not be done to the desired depth and the underlying soil is hard, it will pay to run the subsoil plow.

Ground is in proper condition for plowing when it is neither too wet nor too dry. Under no circumstances should ground be plowed when wet, since plowing under such circumstances injures the physical condition of the soil to an extent that often requires years to correct. Plowing should always be done when the ground is in what is called a friable condition, that is, when it is capable of falling apart as the furrow is turned so that there are no air spaces below, as is the case when the ground is too wet or when it is dry and cloddy.

The Seed and Root Beds

The seed requires a uniformly fine, firm, moist bed in order to produce a quick and uniform germination, which is especially desirable in beet culture. The more quickly the seeds germinate, the more certain is a good stand, which is the first requirement of a satisfactory crop. The plants require a fine, firm, moist, well-aerated root bed in order to make a satisfactory growth. The root bed must be fine and firm because the plants must be held firmly in place during their entire period of growth, and the soil particles must be closely in contact with the feeding rootlets. The soil must be moist enough to supply the plants with mineral food in solution and with enough water to promote constant and rapid growth.

At the same time there must not be in the soil for any considerable period of time so much water that a free interchange of soil gases can not take place.

If the ground is properly plowed in the fall when its physical condition is right, the root bed will be fine and free from air spaces. The winter moisture will usually pack the fall-plowed ground, so that the root bed will be firm. In the absence of natural winter rain or snow, winter irrigation should be practiced; otherwise, two of the most important objects of fall plowing will be lost, namely, the firming of the seed and root beds and the changes in the soil due to freezing and thawing.

If the ground is not plowed until spring, the seed and root beds must be artificially packed. This can best be done with a subsurface packer, which should follow immediately behind the plow. The packer should be followed immediately by the harrow, in order to form the necessary mulch and to retain the moisture in the soil. This mulch should be maintained until planting time, when, if the seed bed is not sufficiently firm, the roller and harrow should be used until the proper degree of firmness is produced. Due regard should be given to the condition of the soil when these implements are used, so that the flocculent condition of the soil is not destroyed. The ground should be so firm before the seed is put into it that even the horses' feet make but little impression upon it.

Another important point in preparing the ground for beets is to see that it is properly leveled. A properly leveled field can be irrigated much more quickly, and, furthermore, if not properly leveled there will be high spots where the beets suffer from lack of sufficient moisture and low spots where the plants are injured by too heavy watering.

Drainage

At first thought, drainage in an irrigated section of the country might seem unnecessary, but experience has shown that under certain conditions the constant applications of water cause the soil to become water-logged.

There are two general systems of artificial drainage that may be used for carrying off the excess of water or for removing the excess of salts from the soil, namely, (1) the open ditch and (2) the blind ditch in which tile or a similar conducting channel is used to aid the flow of the water through the ground. The blind ditch is most often used, and while its initial cost is somewhat greater than that of the open ditch it is more economical in the end, since it still allows the use of the land and if properly constructed does not require the expenditure of time and labor necessitated by the open ditch to keep it in working order.

Irrigation

The proper use of irrigating water is one of the most important factors in the growing of sugar beets under irrigation. The time and method of application and the quantity of water used are the essential considerations in the irrigation of sugar beets. In all irrigated sections there is some precipitation in the form of rain or snow, although this precipitation is uncertain both as to time and amount. However, it should always be conserved and utilized to the fullest extent and the irrigating water should be looked upon as an insurance to carry the crop over periods of drought. It is usual in some localities to irrigate beets up; that is, the seed is planted in dry ground and the field is then flooded in order to germinate the seed. This is a poor practice and should be avoided whenever possible, especially in fields in which the soil has a tendency to form a crust. It is much more satisfactory to irrigate before planting if enough natural moisture can not be retained in the soil to produce germination.

In irrigating before germination it is generally best to corrugate the land, making the corrugations 5 or 6 inches deep and about 20 inches apart. The water should then be run into the corrugations until the ground is thoroughly wet. As soon as the surface of the ground is sufficiently dry to work it should be harrowed down and planted. Whether the germination is produced by the moisture already in the soil or whether it is produced by irrigation, the plants should be carried just as long as possible after they are up before they are watered. The object in withholding the water as long as possible is to produce long roots, since long roots are essential for a good tonnage.

In watering beets after they are up they should never be flooded, but should be watered in furrows between the rows. This is especially important while the beets are small, since flooding at that time is likely to scald the beet stems and to produce a crust on the surface of the ground. Usually suitable furrows between the beet rows can be made by means of irrigating shovels, which may be attached to the cultivator. If the furrows made in this manner are not deep enough and smooth enough to carry the water readily, which will depend upon the slope of the land and the nature of the soil, they should be logged out. This can be done by running the corrugators behind the cultivator. The same implement can be used to prepare the ground for watering before planting and after the beets are up.

After the furrows are properly prepared, the water should be allowed to run slowly through them, so that they will not overflow and so that the ground will be thoroughly wet down and the water seep out to the beets. After each watering the ground should be cultivated just as soon as the surface is dry enough to work. The mulch produced by the cultivator should be maintained by frequent cultivation in order to hold the water as long as possible.

The quantity of water that should be applied in order to produce a crop of beets can not be stated in specific terms, since the water absorbing and retaining ability of different soils varies and the rate of evaporation varies both in different localities and in the same locality under the constantly changing atmospheric conditions. The plants themselves should be the index as to the quantity of water required. So long as the beets have a fresh appearance and a bright-green color they are not suffering for lack of water, and if furrow irrigation is practiced there is little danger of giving them too much water. A dark-green color of the beet leaves usually indicates that the water supply in the soil is running low. This is often followed by a wilting of the beets and a consequent retardation in growth. If the wilted beets fail to revive during the night, practically no growth can take place and water should be applied immediately.

Holding the Moisture

By nature soils vary within wide limits as to their water-holding capacity. For example, a fine, compact soil is capable of holding more moisture than a coarse or loose soil.

Humus affords a good medium in which the soil organisms can live and thrive and liberate plant food, but they can perform their functions to a much higher degree because of the additional moisture which the soil is able to retain on account of the presence of the humus. If, then, the soil has been supplied with the requisite amount of humus and has been plowed uniformly deep at the right time, much has been done toward furnishing the plants with the moisture needed for plant growth. Special attention should then be paid to keeping the surface of the soil constantly in the form of a mulch. This mulch acts as a blanket in retarding evaporation from the soil below. Everyone is familiar with the moist appearance of the ground under a layer of straw, manure, or other loose covering as compared with the exposed surface of the adjacent ground.

Planting the Seed

If the seed bed has been thoroughly prepared, the principal factors to be considered in connection with planting the seed are the time and depth of planting, the quantity of seed used, and the distance between rows. The seed should not be put into the ground until the soil is warm enough to produce a quick germination and a rapid subsequent growth. If the seed lies in the ground when the conditions are not right for germination it is liable to rot, and even if it does not rot, the resulting plants, when they do finally develop, will usually be weak and unsatisfactory.

The desire to give the plants every advantage of a long season often leads to the mistake of planting too early. Experience has shown that almost invariably the plantings that are made later, when the temperature conditions for germination and growth are right, give the best results in tonnage and quality, and the beets usually mature in advance of the earlier plantings. On the other hand, the planting should not be delayed until the moisture has escaped from the seed bed.

The seed should be planted just as shallow as is consistent with quick and uniform germination. The depth of planting will vary, therefore, with the nature of the soil and the condition of climate. The seed should always be put into moist soil and the soil should be capable of holding its moisture long enough to produce germination. It is questionable whether it is ever wise to plant more than 1½ inches deep, for the reason that the beet seed proper is comparatively small and the young plant must be able to get through to the light by using the reserve plant food in the seed.

As an aid in holding the moisture in the soil, the drill should be provided with press wheels, which exert a firm, even pressure upon the soil directly over the drill row. Furthermore, a firm soil acts like a lamp wick and draws the moisture up from below.

Plant all the seed at a uniform depth. The importance of this will be apparent when we consider the operation of thinning the beets. Only two conditions are necessary in order to plant at a uniform depth. First, the surface of the ground must be smooth and firm, and, second, the drill shoes must each stand on the same level.

In order to get a good stand of beets, which is the first requisite of a satisfactory crop, plenty of seed must be used, so there will be no gaps or spaces of any considerable distance where there are no beets. Usually from 15 to 20 pounds of seed per acre will be sufficient to accomplish this result. If a large number of seeds germinate at the same time, each plantlet will help others to get through to the light; hence the importance of plenty of seed in a well-prepared seed bed.

Experience has determined that in general the most satisfactory distance between rows is from 18 to 22 inches. It is evident that very fertile soil capable of holding an abundance of moisture will yield better results with narrow rows than will a less fertile soil with a lower water-holding capacity.

Spacing and Thinning

As already indicated, the present method of planting beet seed is in solid rows instead of in hills, in order to obtain a more uniform and nearly perfect stand of beets. Having secured a good germination it next becomes important to thin the beets down to one in a place at suitable distances apart in the row to produce a good crop. The first step in reducing the beets to one in a place is that of spacing the beets, which is usually done with a hand hoe used at right angles to the row. In this manner a large number of the plants are cut out and the remaining beets are left in small tufts at intervals of 8 to 12 inches in the row. In performing this operation the hoe should be struck just deep enough so that the beets cut off will not grow again and so that all weeds that may have started in the row will be destroyed.

Several machines have been devised for spacing beets, but they have not come into general use.

As soon as the beets have been spaced, the tufts should be thinned to one in a place. This work must be done with the hands, since the beet plants stand so close together that no machine has been devised that is capable of doing the work satisfactorily. It is seldom the case that two beets left in the same tuft will produce the same weight of beet roots that would have been produced by either of the beets alone.

The beets should be spaced and thinned just as soon as possible after they are up. This can usually be done when the plants have from 4 to 6 leaves.

Cultivating

There are three principal objects to be accomplished by the use of the cultivator; namely, the destruction of weeds, the retention of moisture, and the interchange of gases in the soil. The purpose for which the cultivator is operated should be kept in mind, and the cultivator should be fitted with attachments accordingly. In using the weeders care should be taken that they do not form a crust just below the mulch produced by the weeder blades. This may be avoided by attaching calf-tongues just back of the weeder and so setting them that the points operate a little deeper than the weeder blades.

Some growers are partial to the disks when the beets are small. These are useful if the main object is the formation of a mulch or if a light crust has formed which it is desired to break and at the same time to form a mulch. The disks, if properly set, prevent the dirt from being thrown over the young beets, which is a point that should be strongly emphasized at every cultivation, regardless of the kind of attachments used. The objection to the disk is that it leaves a furrow on either side of the beet row, and consequently the plants stand on a ridge, which is inclined to dry out. To avoid this condition a bull-tongue should be attached back of each of the disks and so adjusted that the furrows formed by the disks are filled in with the loose dirt, so that the surface of the ground is level.

While the beets are small it is safe to cultivate fairly deep and quite close to the plants. The depth to which the ground is stirred when the beets are small should never be as great as the depth to which the roots have penetrated and never need exceed from 3 to 4 inches in order to accomplish the object of the cultivation. As the beets get older it is usually advisable to set the cultivator so that it does not work so deep or so close to the beets, for the reason that the feeding roots must not be disturbed. The manner in which the beets are handled while small, especially with reference to the soil moisture, will govern to a great extent the position of the feeding roots. If the ground is kept rather moist near the surface the feeding roots will develop near the surface and great injury may be done by the later cultivation. This emphasizes the importance of withholding the water from the young beets as long as possible, so that the main root will be long and the feeding roots formed well down on the main root. If this is done a deeper mulch and one that extends closer to the beets can be maintained without injury to the plants. This will be very helpful in retaining the moisture in the root bed and also in maintaining a free circulation of gases in the soil.

Before cultivating it is always advisable to examine the plants with reference to the length of the taproots and the location and length of the feeding ones.

Hoeing

Beets receive their first and in many cases their only real hoeing at the time they are thinned. At this time the ground is or should be thoroughly stirred around each beet. The hoeing should be deep enough to destroy all weeds in the beet rows and to form a continuous mulch around and between the beets. Unfortunately, in practically all sugar beet localities all hoeing after the beets are thinned consists simply in cutting out the weeds in the beet rows. The consequence is that the ground in the beet rows is not stirred from the time the beets are thinned until they are harvested except at the points where weeds appear. This permits the formation of a crust, in many cases the entire length of the beet rows, through which an enormous amount of soil moisture escapes.

The destruction of weeds is of vital importance, since if allowed to grow they rob the soil of both moisture and plant food, but the stirring of the ground between the beets in the row should not be overlooked.

Harvesting

The proper time for harvesting the beets is usually determined by certain tests which show the sugar condition and purity of the juice in the roots. Each sugar company has its standard for these factors of quality, and until the roots measure up to this standard they are not considered sufficiently mature to be harvested profitably. Harvesting beets consists of several distinct operations; i. e., lifting, pulling, topping, piling, and hauling.

Lifting the beets consists in loosening them so that they can be easily pulled. Two forms of lifters are in general use. One is a double-pointed implement so constructed that one point passes along on either side of the beets and at a suitable distance from the surface so that the beets are slightly raised out of the ground. The other is a single-pointed implement somewhat resembling a subsoil plow. This passes along on one side of the beet row and loosens the dirt so that the beets are easily pulled and is called a side lifter. The side lifter usually has a lighter draft than the double-pointed implement. Aside from the draft, the important points are that all the beets be loosened and that as few roots as possible be broken. Both of these factors are often a matter of good driving. After the beets have been loosened they are pulled and thrown in piles or rows. The number of beet rows used in making one row of piles, usually consists of from 16 to 24 rows of beets.

After the beets have been pulled they are topped. This consists in cutting off each beet at the line of the lowest leaf scar, which is usually done by one stroke of a heavy knife. The object in topping the beets is to remove the leaves, which contain but a small amount of sugar, and to remove the crown or upper part of the beet, which contains a large percentage of the mineral matter taken up from the soil. The mineral matter prevents a given amount of sugar from crystallizing and for this reason should not be allowed to get into the juices in the mill. When the beets are topped the roots are thrown into piles, from which they are loaded on wagons by means of specially constructed forks; that is, the fork tines have knobs on the ends to prevent the tines from puncturing the roots. Before the beets are topped the ground where they are to be piled should be freed from clods and refuse material, so that nothing but clean beets will be forked to the wagons. If the beets can not be hauled immediately after topping they should be covered to prevent evaporation or freezing. If the weather is not cold enough to freeze the beets it is usually sufficient to cover the piles with the beet tops, but if there is danger of freezing a sufficient quantity of earth should be thrown over the piles to prevent the roots from becoming frosted. When the beets are delivered to the sugar mill or loading station, they are tared. The tare consists of two parts, the dirt tare and the crown tare. The dirt tare is the percentage of dirt that clings to the roots when loaded and the crown tare consists of the percentage of crown left on the roots, due to improper topping.

Crop Rotation

Every farm should have a well-defined system of crop rotation. The object of crop rotation, if properly arranged, is twofold. Each crop should leave the ground in better condition for the next crop than it was before, and each crop should prevent the propagation and development of plant pests. The fallacy that sugar beets injure the soil has not only been exploded, but just the reverse has been found to be the fact. It is true that sugar beets take out of the soil the same elements that are removed by other crops, but in slightly different proportions. But, as has been stated, a large part of these mineral elements is in the top, which, if properly handled, will be returned to the soil in the form of manure, so that in the end but little plant food is removed from the soil by the beet crop. Furthermore, the beet crop leaves the soil in good tilth for the next crop. Experience in all sugar beet countries has demonstrated the fact that larger crops of grain can be grown after beets than after any other crop so far as known. This seems to be due to the excellent condition in which the soil is left by the beet crop and to the depth of the root bed occupied by the beet roots. It is not apparent that sugar beets add any fertilizing material to the soil, but the fibrous roots that are left in the ground when the beets are harvested improve its physical condition.

If sugar beets are to be one of the crops in the rotation system, the crop preceding the beets should be of such a nature that it can be harvested in time to plow the ground for beets in the fall. One of the crops in the system should be a legume, such as alfalfa, peas, beans, etc. These are nitrogen-storing crops, and if the soil is deficient in humus, as is the case in most of the irrigated sections, a green crop should be plowed under. Not more than two sugar beet crops should be grown in succession on the same field, chiefly for the reason that a continual cropping with sugar beets tends to promote the development of serious pests, such as leaf spot, root rot, and insects. It is true that more than two crops of beets may sometimes be grown in succession, but it is a dangerous practice and should be avoided.

Fertilizers

As a rule, the soils in the irrigated sections of the country are rich—that is, they contain in abundance the mineral elements necessary for plant growth; but in many cases these mineral elements are not soluble. Under such circumstances the soils, while rich, are not fertile. If one or more of the required elements is lacking or is not present in the soil in sufficient quantity to produce a normal plant growth, it is clear that such element or elements should be added in an available form. If, however, the necessary plant foods are all present in the soil but some of them are not soluble, the problem is entirely different and consists in so treating the soil that all the elements are reduced to soluble forms. Frequently the fertility of a soil may be increased by giving it proper tillage at the right time without the addition of any material.

The vegetable fertilizers in common use are stable manure and green crops. The principal function of the vegetable fertilizer is to so improve the physical condition of the soil that the elements already in the soil are rendered soluble and therefore available for the plant. Nearly all irrigated soils are deficient in humus, and for this reason it is important to make use of the greatest possible amount of stable manure.

As a rule, the amount of stable manure produced upon most farms is insufficient to supply the required quantity of humus to irrigated soils. For this reason the stable manure should be supplemented by plowing under green crops. If the supply of nitrogen in the soil as well as the supply of humus is deficient, nitrogen-storing plants, such as alfalfa, clover, peas, beans, etc., should be used as a green fertilizer. If the humus only is deficient, such crops as rape, rye, sorghum, etc., may be used. A soil which is deficient in one or more of the mineral elements will not respond to the fullest extent to the addition of mineral fertilizer unless there is a sufficient amount of humus present to put the soil in good physical condition. Therefore, the physical condition as well as the chemical composition should be carefully considered in the effort to increase the fertility of soils.

Live Stock

One of the most important adjuncts of a farm on which sugar beets are grown is live stock, especially dairy cows. It is doubtful whether any sugar beet territory can build up a permanent agriculture unless considerable attention is given to the production of live stock. Not only will the live stock, if properly handled, produce an important part of the farm income, but they are very essential in the matter of soil improvement, which is brought about through the proper use of the barnyard manure. The keeping of live stock enables the beet grower to make the best possible use of the beet tops. This feed, in connection with roughage which is easily produced, keeps the live stock in good condition and enables the farmer to return the mineral elements in the tops to the soil and at the same time to increase the supply of soil humus.

Sheep as well as cattle thrive on beet tops, but it is wise to feed them sparingly at first and to increase the allowance as the stock become more accustomed to this feed. The practice in some localities of pasturing the tops after the beet roots have been hauled from the field has the advantage that it saves the time and labor of hauling them, but it is more or less wasteful. Furthermore, the ground is often injured by the trampling of the stock, so that altogether the most satisfactory plan is to gather and haul the tops to the feed yard, where they should be fed in properly constructed racks to avoid waste.

By-Products

The by-products of the beet field and sugar mill that are of special importance to the farmer are the beet tops, the pulp, and the waste lime. Many farmers sell the tops for a cash price ranging from $2.50 to $5 per acre. In this case the beet grower is the loser, for two reasons. In the first place, the tops are of greater value to him as a stock food; and, in the second place, if he allows the tops to leave his farm he loses their manurial value.

The most economical way to handle the tops is to gather them into piles soon after they wilt and before they become thoroughly dried. However, if any disease, especially leaf spot or crown rot, is noticeable on the beet leaves and crowns, the manure should be used only on ground that is not to be put into beets for two or more years; or, better, the freshly wilted beet tops should be put into the silo, preferably mixed with cut straw or corn stover. Leaf spot pores are all killed in the silo.

Beet pulp is likewise an excellent stock food. This by-product is the refuse that remains after the beet roots have been sliced and the sugar extracted. As a stock food it may be used either as green pulp—that is, just as it comes from the mill—or it may be dried. The composition of the dried pulp as guaranteed by one of the large dealers is as follows: Protein, not under eight per cent; fat, not under one-half of one per cent; sugar and starch, not under four per cent; fiber, not over 20 per cent; extract (carbohydrates), not under 58 per cent. Total carbohydrates, including fiber, not under 76 per cent; ashes, two and one-half per cent. While the pulp, either green or dried, is an excellent stock food it is not a balanced ration and should therefore be fed with other protein material.

Waste lime is a by-product of the sugar mill which, under certain conditions, is of considerable value to the farmer in correcting the acid condition of the soil. It is well known that a soil should be neutral or slightly alkaline in order to produce the best results. Ordinarily, an application of from 500 to 2,000 pounds of waste lime per acre will correct the acidity and otherwise improve the soil.

Summary

Sugar beet soil should be selected with reference to its fertility, its physical condition, its previous cropping, and its ability to be properly drained and irrigated.

The ground should be plowed to a good depth in the fall and every effort made to retain the moisture in the soil from the time the previous crop was harvested until the beet crop is laid by.

The seed and root beds should be so prepared that they will be fine, firm, moist, and well aerated, with a sufficiently lumpy mulch on the surface to prevent blowing.

Beet ground should never be flooded after the seed is planted.

The soil should be well supplied with humus.

Beet seed should be planted in moist soil, but not more than one and one-half inches deep.

Beets should be spaced and thinned just as soon as they are large enough to handle.

Beets should be cultivated and hoed often enough to destroy all weeds and to keep the entire surface of the ground covered with a mulch.

Beets should always be rotated with other crops in order to keep the soil in good tilth and free from pests.

Live stock, especially dairy cows, should always be found on beet farms.

The by-products of the sugar beet and of the sugar mill are worthy of careful attention.

Farmers' Bulletin 567.

Beet-Sugar Crop in the United States for the Year 1911-12

State	Factories		Area harvested	Yield	Value per ton	Beets worked	Sucrose	Sugar manufactured	Recovery		Loss of Beets
	No	Run							Beets	Sucrose	
		Days	Acres	Short tons	Dollars	Short tons	Per cent	Short tons	Per cent	Per cent	Per cent
California...	10	98.5	99,545	10.42	5.54	1,037,283	18.95	161,300	15.55	82.04	3.40
Colorado...	14	63.3	86,437	11.07	5.55	957,142	15.44	124,800	13.04	81.22	2.40
Idaho......	3	91	17,052	12.11	5.02	206,367	16.65	26,730	12.95	77.80	3.70
Michigan...	17	122	145,837	9.90	5.74	1,443,856	14.59	125,500	8.69	59.55	5.90
Utah.......	6	96	33,950	13.03	4.81	442,310	15.98	57,280	12.95	81.04	3.02
Wisconsin...	4	106	23,241	11.02	5.51	256,124	14.23	23,640	9.23	64.86	5.00
Other States	12	83	67,815	10.61	5.48	719,251	15.16	80,250	11.16	73.60	4.00
Total or average...	66	94+	473,877	10.68	5.50	5,062,333	15.89	599,500	11.84	73.92	4.05

Compiled in the office of Cotton and Truck Disease and Sugar-Plant Investigations, Bureau of Plant Industry.

Sugar Beets in Europe

The following table gives the area and production of sugar beets in European countries in 1912 and 1911, according to a report of the International Institute of Agriculture:

Area and production of sugar beets in specified countries, 1912-11.

Country	Area		Production	
	1912	1911	1912	1911
	Acres	Acres	Tons (2,000 lbs.)	Tons (2,000 lbs.)
Prussia	1,053,454	865,559	14,289,352	6,609,550
Belgium	163,086	150,237	2,094,370	1,626,995
Bulgaria	7,413	7,331	49,604	68,343
Denmark	74,871	61,528	885,729	805,208
Spain	106,438	82,121	1,189,353	964,463
France	606,346	600,280	7,037,204	4,669,083
Croatia and Slavonia	7,413	7,413	99,207	66,138
Italy	130,963	131,260	1,818,795	1,587,753
Roumania	35,491	33,613	352,736	289,962
Russia	1,860,196	1,923,758	14,523,444	14,343,901
Sweden	....	....	1,091,480	905,124

—Crop Reporter, January, 1913.

BEET DISEASES

Beet Scab

Thought to be the same organism as produces the potato scab and affects the roots in much the same way.

Rotation of crops is suggested.

See *Scab* under *Potato.*

Crown Rot

Phoma Betae

Distributed pretty generally throughout the beet growing sections.

Curly Top. See *Beet Leaf Hopper*, this section.

Downy Mildew

Peronospora schachtii

Causes a stunting of the inner leaves. Occurs during the rainy season.

Destroy all affected plants.

Leaf Spot

Cercospora beticola Sacc.

Produces small dead spots in the leaves followed at times by dying of the leaves.

Bordeaux mixture applied at intervals of three weeks.

Root Knot

Caused by the Nematode gall worm.

See under *Potato.*

Root Rot

Rhizoctonia sp.

Appears in the young plant as a decay of the root. Causes the root to fork and become misshapen.

Crop rotation, or, where practicable, soil disinfection seem the best remedies.

Rust

Uromyces betae

Appears as a red rust on beet leaves when grown in the rainy season. Not serious.

BEET PESTS

Beet Aphis, Beet Root Aphis, California Beet Root Aphis. See *Aphids.* See also *Beet Louse,* this section.

The Beet Army Worm

Laphygma exigua Hubn.

Family Noctuidae

Caradrina exigua Hubn.

General Appearance

The adult moth is mottled gray with distinct light markings on the fore wings. It is about one inch in length, with a wing expanse of one and one-half inches. The larvae are slender, dark green in color and distinctly striped.

Life History

The adult moths appear during the months of April and June and deposit eggs, the caterpillars hatching out in May and the last of June and becoming most abundant in August. There are probably three generations a year—the first and last doing the least amount of damage.

Food Plants

The favorite food of the caterpillars is the sugar beet and it bids fair to become quite a serious pest to that crop. Table beets, corn, potatoes, peas, onions, sunflower, lambsquarters, pigweed, saltbush and the leaves of the apple, mallow, wild tobacco, plantain and wild grasses are also attacked.

Poison mash as for other cut worms.

E. O. Essig

Beet Leaf Hopper

Eutettix tenella Baker

The adult is a small, pale yellowish-green species. When fresh or when flying this leaf hopper appears almost white, and for this reason it has often been called the "white fly."

The eggs are white, elongate, slightly curved and tapering at one end, and are thrust into the leaf stem.

The nymphs are very active, pale creamy white or variously colored forms. The commonest form is pale creamy in color with a brown saddle on the middle of the abdomen.

The distribution seems to be general over the West.

The condition called "curly-leaf" or "blight" accompanies the attack of these insects and its severity is in proportion to their numbers.

Remedy

Spray with kerosene emulsion stock solution one to five parts water, using a drag to turn the beet leaves up.

Bureau Entomology Bulletin 66.

Beet Louse

Pemphigus betae Doane

General Appearance

The adult wingless lice are about one-eighth of an inch long; somewhat round-

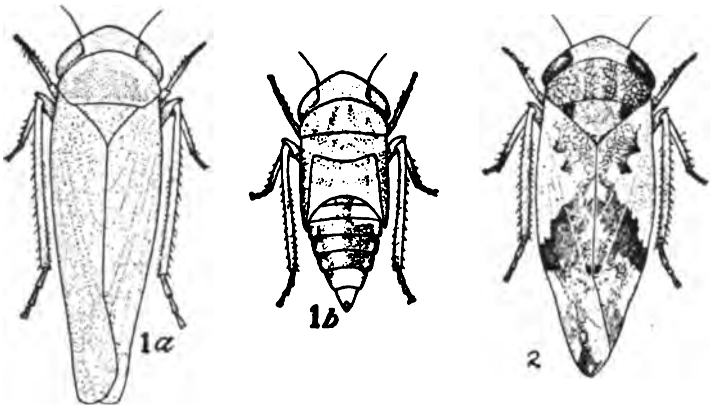

Fig. 1. Beet Leaf Hopper. 1a, Adult of *E. tenella;* 1b, Nymph; 2, Adult of *E. scitula.*

ed or elongated in shape; whitish or pale yellow in color with a large tuft of white flocculence covering the posterior end of the body. The legs, antennae, and spots on the top of the head are brown. The winged lice are a little larger, more elongated and much darker in color. The head, antennae, legs and thorax are black and being usually covered with a fine, white powder appear bluish-black; abdomen dark green. The presence of this pest is easily told by the white flocculence which covers the lice as well as surrounding infested areas on the roots.

Food Plants

As this is a subterranean aphid, only the roots are affected, but often in such a way as to ruin portions of the crop. Sugar beets are the only economic plants attacked to any injurious degree. Wild yarrow, dock, knotweed (*Polygonum aviculare*) are also attacked.

Remedy

Rotation.

E. O. Essig

Blister Beetles

The striped blister beetle or what is sometimes called the old-fashioned potato beetle, frequently attacks the beet. They come in immense numbers and are likely to do serious injury before their presence is observed. They are long, slender beetles with black and yellow stripes. Apply arsenate of lead as soon as the beetles appear.

Flea Beetles. See *Potato.*

Minute False Chinch Bug

Nysius angustatus minutus Uhl.

Family Lygaeidae

General Appearance

The adults are very small grayish-brown bugs, about one-sixteenth of an inch long. The young are somewhat lighter in color, having reddish-brown abdomens and lacking wings. The legs and antennæ appear very long and are dark.

Life History

The eggs are deposited in the spring and early summer by the adults which have hibernated during the winter. The young are dull gray or brownish-red, and collect in great numbers upon the host plants. The life cycle is short, there being many successive broods each year.

Food Plants

The insect is especially destructive to sugar beets grown for seed. It has been collected in large numbers on cultivated flowers.

Control

Soap emulsions and tobacco sprays are excellent remedies. Pyrethrum is also recommended, but is too expensive for large plantings.

E. O. Essig

Plant Bug

Lygus pratensis, etc.

Flattened, sucking bug, nearly one-fourth inch long when full grown, brownish in color, marked with yellow and black. Hibernates under grass and rubbish.

Sucks juices, causing plants to wither and often carries disease from sick plants to others.

Burn all rubbish in spring if this was omitted in fall. Spray young bugs with kerosene emulsion diluted with 12 to 15 parts of water. Collect old bugs by sweeping plants with cheese cloth or muslin net when insects are stupid in early morning or when it is cold.

H. A. GOSSARD,
Wooster, Ohio

SPINACH OF BEET LEAF MAGGOT. See under *Spinach*.

Western Army Worm

Chorizagrotis agrestis Grote

Family Noctuidae

General Appearance

The adult moth is about one inch long and dark brown with gray markings. The caterpillars or army worms attain a length of two inches and vary from pale green to dark brown.

Life History

The general life history is practically the same as that of the variegated cut worm (*Peridroma margaritosa* var. *saucia* Hubn.).

Food Plants

This is a rather serious vegetable pest, attacking beets, cabbage, horse-radish, radish, mustard, turnip, peas, tomatoes, potatoes, onions, celery, rhubarb, corn, grasses, clover, alfalfa and forest and fruit trees.

Poisoned bait, composed of a pound of Paris green to 40 or 50 pounds of bran and sweetened either with cheap sugar or molasses with sufficient water added to make a stiff mash, placed in the infested areas, will kill countless numbers of the worms.

E. O. ESSIG

Beneficial Insects

The California State Insectary Propagating and Distributing Beneficial Insects

The California State Insectary is a department of the state commission of horticulture, equipped and maintained for the purpose of reducing the cost of production of horticultural and agricultural products through the control of injurious insect pests.

The primary object of this institution is to import, collect, propagate and distribute beneficial insects that will prey upon insects destructive to our fruit, vine and grain products. Information is also disseminated as to the best artificial means of control, where the natural methods are not available, both for insect pests and plant diseases.

The state of California leads the horticultural world in the science of controlling destructive insects by natural and artificial methods.

The main purpose of this article is to give the reading public a general idea of the various methods employed by the California State Insectary, in propagating, collecting, holding in cold storage and distributing the tons of live beneficial insects that are annually distributed free, upon application, express or postage paid, to resident growers of California.

This great practical work and its commercial application had its inception in California. The history of its inauguration is so well known and understood that, for the purpose of the present article, it may be passed with the brief statement that, early in the horticultural history of the state, the known means of artificial control or eradication proved inadequate to cope with the invasion of a very serious insect pest of citrus and other trees, known as the "cottony cushion scale" (*Icerya purchasi*) which reduced the citrus output from 8,000 cars to 600 in a single year.

The idea of searching the world for a beneficial insect that would prey upon and control this pest originated in California. The idea was put into practical operation by the introduction of a species of Coccinellidae (Ladybird family) from Australia, known as *Novius* (Vedalia) *cardinalis*, with the result that the then doomed citrus industry of California was saved and the same pest which is always present in limited numbers, was commercially and continually controlled all these years at no expense to the grower, except a two-cent stamp on the letter to the Insectary requesting that a colony of Australian ladybirds be sent to him to check the threatened outbreak of the pest.

Encouraged by the success of this first undertaking, the work has been successfully prosecuted for many years, until today California has the largest insectary in the world devoted exclusively to the introduction, propagation and dissemination of beneficial insects.

By careful study it has been determined that, in a majority of cases, what in California is termed an "insect pest" is usually a foreign destructive insect that has been accidentally introduced into the state without its natural insect check (who used it not only for food for itself, but upon which to feed and propagate its young).

The introduced species increases enormously and in a remarkably short time, by sheer force of numbers, becomes what we term "an insect pest."

From the above statement the work of the state Insectary can be easily understood. Its first duty is to locate the home of the natural insect enemy, which is usually the country from which the pest was introduced. The beneficial form is then sent to the Insectary, either through correspondence with some foreign entomologist or by sending our entomological explorer direct to that country.

After receipt at the Insectary several generations must be bred in confinement in order to segregate the secondary and even tertiary forms before any adults of the species desired may be liberated in the open.

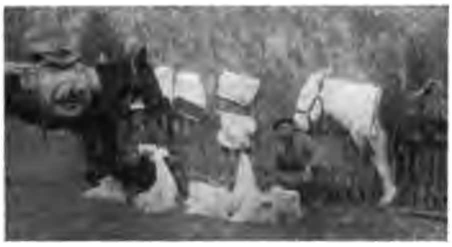

Fig. 1. Field Agents with 300 Pounds of Ladybirds in sacks at a pack train station. Sacks are only half filled to allow the beetles to move slightly and to avoid crushing when packed on the mules. Sieves, pans, brushes and sacks used for this collecting are hanging on the fence.

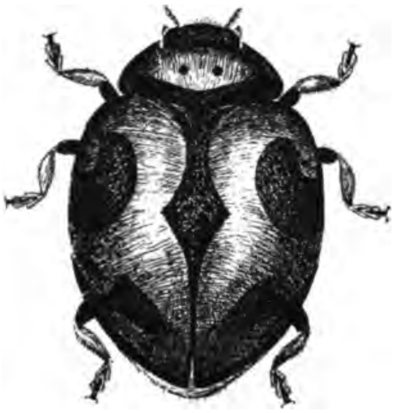

Fig. 2. The Vedalia (*Novius cardinalis* Muls). Slightly less than one-quarter of an inch in length and oval in shape. The color pattern is very pronounced and striking, being red and black. In the females red predominates while in the males there is more black. The larvae are often over one-half of an inch long and lead-gray in color with reddish sides. They are often covered with whitish powder from the egg sacs of the cottony cushion scale. The eggs are a little larger than those of *Novius koebelei*, but are the same color and laid in similar places. The young feed upon the eggs and young scales and do great execution. The great prolificness and appetite of this species enables it to do what no other predator has yet done. It disappears with the host and is constantly being sent out by the State Insectary. Introduced in California by Albert Koebele. It feeds entirely upon the eggs and young of the cottony cushion scale (*Icerya purchasi*). To this beetle is accredited the salvation of the citrus industry in California, which was threatened with destruction by the above scale.

To this part of the work too much care cannot be given, as the success or failure of the entire undertaking hinges on the careful segregation of the species at this point.

To successfully establish an introduced species, several additional importations must be made and adults liberated as in many species if but a single introduction is made, in-breeding after a remarkably few generations will not only dwarf the species but actually stop reproduction.

Many failures to establish foreign species during the past is directly traceable to this very important feature, owing to lack of sufficient knowledge on the part of the collector who has been content with but a single introduction. This is especially true of the Coccinellidae (Ladybird) family.

We find then the main essential factors toward successful foreign introductions

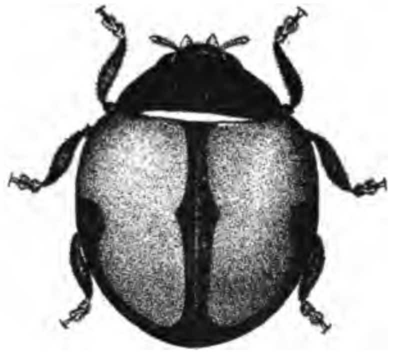

Fig. 3. Koebele's Ladybird Beetle (*Novius koeblei* Olliff). Adult male, greatly enlarged (original drawing by Birdnekoff). A very small species being not longer than one-eighth of an inch: the males are bright red with dark markings; the females red with dark head, prothorax, and marginal spot near the middle of each wing cover. The larvae are dark red and about one-fourth of an inch long. The small oblong red eggs are deposited by the females on the egg sacs of the host and hatch within a few days. The young immediately enter the egg sac and begin feeding upon the eggs and young hatched scales. It was first introduced by Albert Koebele and is continually being re-distributed by the State Insectary. It feeds upon the cottony cushion scale. (*Icerya purchasi*). This species is often more numerous and does greater execution than does the Vedalia (*Novius cardinalis*), for which it is usually mistaken.

are, first, the careful segregation of all secondary forms, which must be immediately destroyed and not a single individual allowed to escape. Packages must be opened in an air-tight room or tight glass case; one end covered with a black cloth curtain into which holes are cut. The package is placed inside the case, the operator puts his arms through the holes in the curtain and thus works inside the case. Second, additional importations to enable cross-breeding and to prevent inbreeding, also to give the species the advantage of different seasons in which to become established, or, in case the first shipment would meet with disaster upon being liberated.

Our foreign importations are shipped almost entirely when they are in the larval (young) or pupal (quiescent) stage and are placed in cold storage during transit.

The intricacies of cold storaging insect species would require chapters to even begin to explain the various processes and, all told, it is a subject that does not lend

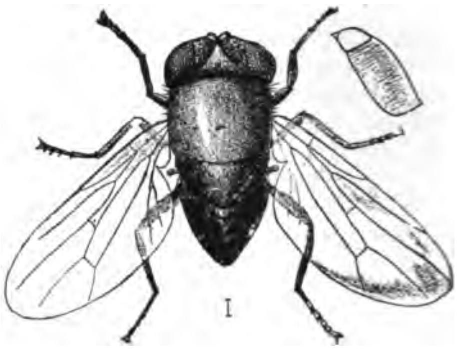

Fig. 4. Dipterous Parasite of the Cottony Cushion Scale (*Cryptochaetum iceryae* Will. [Family Agromyzidae]. *Lestophonus iceryae* Will.). The adults of this very beneficial insect are exceedingly small two-winged flies about one-sixteenth of an inch long. The head and thorax are metallic blue and the abdomen bright iridescent green. The antennae are black; legs black or dark brown with feet light; wings grayish hyaline with dark brown veins. The eggs are deposited by the females in the egg sacs of the cottony cushion scale and the young maggots feed upon the eggs of this pest. The entire life history is passed within the protecting sac of the host, the adults emerging as by magic from the masses of the scale. This fly is practically confined to the citrus-growing sections of Southern California and is more often found in Los Angeles, Orange and San Diego counties. While it is not as consistent and reliable in its work upon the cottony cushion scale as are the ladybird beetles (*Novius cardinalis* and *N. Koebelei)* yet its work is often phenomenal. Certainly its rearing and distribution is well worth while.

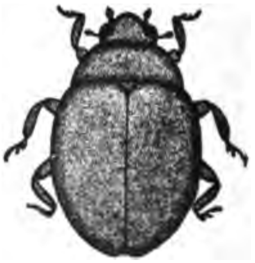

Fig. 5. Black Ladybird Beetle (*Rhizobius ventralis* Er.). The adults are smaller than those of the common red ladybird; rather oval in shape; black and covered with fine hairs which give them a grayish appearance. The abdomen is salmon colored. The young are dark brown or black and covered with many spines. The eggs are deposited singly or a few at a place among the egg masses of mealy bugs, under the bodies of the black scale or among other scale insects. The numbers of the host are so great that the actual good done is not so marked as in the cases of many other predators. The adults move little except when annoyed. This species was imported by Albert Koebele, especially as an enemy of black scale (*Saissetia oleae*). The young feed upon the eggs of the black scale, mealy bugs, hemispherical scale and other similar insects.

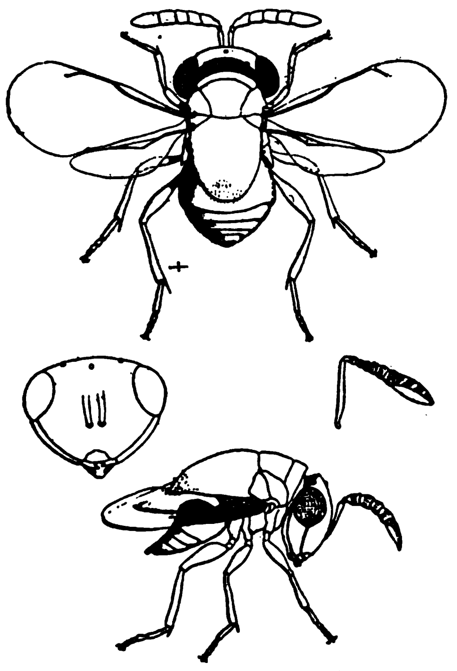

Fig. 6. The Scutellista (*Scutellista cyanea* Motsch. [Family Encyrtidae]). The adult is a small four-winged parasite, less than one-eighth of an inch long, robust and metallic steel-blue to nearly black in color. The small oblong white eggs are placed under the shell of the black scale. They are somewhat larger than the eggs of the scale and hatch in from five to six days into crescent-shaped white legless larvae, which feed upon the eggs of the black scale for 15 to 20 days, when they pupate and after another like period emerge as adults from the shells of the scale through circular holes cut for this purpose. The adult lives a little over a week. It does very effective work on the black scale in certain sections. It also works on the hemispherical scale.

itself readily to explanation but is a case of knowing "when to" and "when not to," as each species requires different care, treatment and temperature.

At the Insectary we propagate on various host plants, the destructive forms upon which we feed the beneficial forms that later on are distributed to the orchards.

The several pictures accompanying this article will give the reader an idea of the manner in which this work is carried on.

Still another very interesting phase of the work is the conservation and distribution of native species of beneficial insects.

Many native species propagate or hybernate in immense quantities in certain sections of the state, which are collected when available, held in a state of artificial hibernation by the aid of cold storage, later to be judiciously distributed into new sections, where they will thrive and perform wonderful service in destroying destructive forms which are present.

The most prominent among these which we will use to illustrate this work is a native species of Coccinellidae (Ladybird) known scientifically as *Hippodamia convergens*. This phase of the work has been set forth by the writer in Vol. III of The Monthly Bulletin, published by the state commission of horticulture, of which the writer is assistant editor, and from which the following is a portion:

Throughout California the fact is quite well known that the State Insectary distributes, each year, several tons of coccinellids of the species *Hippodamia convergens*, commonly known as ladybirds, to growers of cantaloupes,, prunes, apples, pears, vegetables, seeds and garden truck, for the destruction of aphid species.

Our growers know that it is only necessary to make application to the superintendent of the Insectary, for colonies of these beneficial insects, stating the nature and acreage of the crop grown, to receive, at the proper time, a consignment of 30,000 for each ten acres, by express, charges paid, and with a free return on the shipping crates.

This new and very remarkable form of enterprise has proven a great practical success, the ladybirds being used to destroy aphids or plant lice that attack the

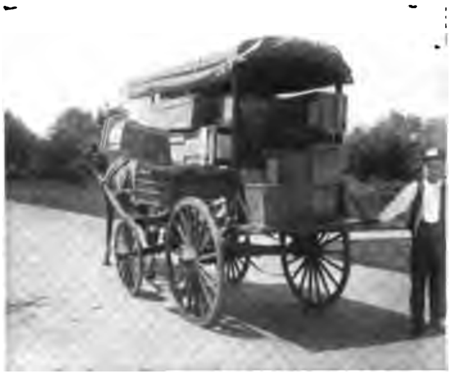

Fig. 7. Wells Fargo Express taking a load of Ladybirds from the Insectary for delivery to the fruit growers over the state. Several loads a day are taken during the shipping season. Six colonies are put in one crate.

above-mentioned crops. This line of work had its origin at the California State Insectary, together with the process of hibernating this and various other species in enormous quantities in artificial cold storage.

Experiments have been conducted along this line at the Insectary, whereby the *Hippodamia convergens* has been successfully kept in hibernation in cold storage, without impairing the vitality of the species for seven months and 14 days.

This particular line of work was inaugurated through practical necessity, owing to the fact that the chief obstacle to the raising of cantaloupes in California, especially in Imperial valley, has been the attack of the melon aphis (*Aphis gossypii*), often ruining whole fields in three or four days, and no mechanical or other means of fighting them had been found effective; indeed, it was only possible to get rid of them by destroying the infested vines.

The use of ladybirds for the destruction of aphids has gradually spread from their originally appointed work, until now the Insectary ships crates upon crates to practically every county in the state of California, and to growers of almost every horticultural product subject to the attack of aphid species, even including city (ornamental) street trees and home gardens.

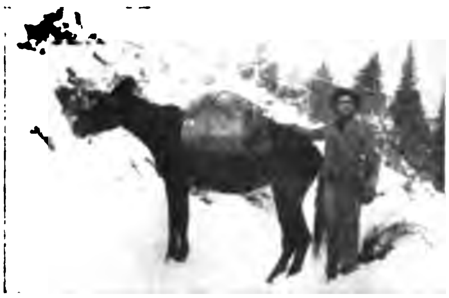

Fig. 8. One Hundred and Thirty Pounds of Ladybirds on Pack Mule. Nine miles through the snow to the packing house.

The particular coccinellids (*Hippodamia convergens*) used in fighting aphid infestations are a species native to California. They are of a predatory habit, and their special prey and chosen food are the aphids, upon which they feed both in the larval and adult stages.

The best results are obtained by placing colonies in the infested fields or orchards at, or just before, the first appearance of the aphids; the object being to prevent the increase of these destructive insects.

Again, the female coccinellid, if the natural food is scarce in an orchard or field, is thus forced to search diligently for aphids, and will distribute her eggs in proportion to the number of aphids present; whereas, if the colonies were not placed until after the aphids had become abundant, she would deposit practically all her eggs in the same place. The same rule will apply to practically all cultivated crops, and therefore it is important that applicants for colonies of this particular species should place their order early, and again notify the Insectary when the very first aphids are noticed, and ask that their colony be sent them immediately.

It has been thoroughly demonstrated that by following such a procedure, with the help of the ladybirds, orchards and fields have been kept commercially clear of this obnoxious insect. So great is the demand for ladybirds by growers of melons and all other kinds of fruit, that the Insectary has been obliged to organize, upon a very considerable scale, the work of collecting these insects.

The enormous amount of work connected with the locating, collecting and holding in hibernation, the boxing, crating, shipping and distributing of several tons of live insects is little realized by the average reader. The illustrations accompanying this article, together with the following, will give some idea of how this work is conducted:

Starting about November 1st, the field men go up into the mountains to locate the hibernating colonies, which are usually found among pine-needles on sunny, well-drained slopes, usually in close proximity to running water. They are securely hidden, and inexperienced collectors may pass and repass directly over such spots and the presence of the colony will never be detected. In fact, the idea generally prevails in the minds of the mountain residents that the beetles come to the sections in the spring, and the idea is scouted that colonies of beetles spend the winter under the snow.

At this season, however, only a few of the beetles, relatively speaking, are discoverable. They are the first arrivals which have sought winter quarters early, but later on the colonies thus started rapidly grow in size. Other ladybirds join them, probably attracted by a peculiar insect odor, which they recognize, and so in the course of a few weeks immense numbers assemble.

Just how these over-wintering colonies are located, if explained, would hardly be believed by the general reading public. In fact, it is a sort of sense that is hardly subject to analysis. Our field men know, by past experience, where the most likely places are, and how also to find the beetles. We can at least immediately tell where they are not, thus eliminating a great deal of unproductive territory from the work constituting the preliminary scouting.

Whenever a colony is located, we dig into the pine-needles, moss, leaves, etc., and through past experience we are enabled to estimate about how many pounds the said colony will yield. A little map is then roughly drawn on a card, a tree is blazed marking this spot, and the colony numbered with a notation on the back of card, giving conditions, probable amount obtainable, together with any information the collector thinks would be useful.

It will be understood that the work above described is but the beginning of the real work of collecting, which starts the last of December and continues until the last of February. Our field men at that time again go into the mountains and establish a camp as a center of operations, and proceed to make collections from colonies previously located.

When practicable a mule is taken along from the camp to carry the ladybirds, two men usually working together, and with fairly good luck they will collect from 50 to 100 pounds of the beetles in a day.

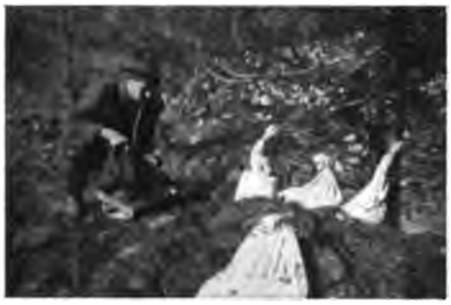

Fig. 9. Collecting Ladybirds. Showing method of using sieve. Note the masses of ladybirds upon the rocks and rubbish.

Various methods of separating the ladybirds from the pine needles and debris have been tried out and discarded. The most successful arrangement, and the one now in use, has been a canvas sack, open at both ends, with a coarse mesh sieve sewed in one end of the sack, composed entirely of wire, the bottom of the sack being tied with a drawstring and securely fastened. The use of this is quickly seen when the men get to work, for the beetles are found in clustered masses, often as big as one's two fists, under the leaves and pine needles on the ground. Two men usually work together; one man scoops them up and throws them into the sieve, while the other man passes them through, rejecting as much of the vegetable and other debris as he can possibly get rid of.

When the sieve-sack is full they are transferred to ordinary flour sacks, securely fastened at the end, and laid out on the snow, later to be taken out via the mule pack train to the railroad.

Fig. 10. A Single Shipment of Ladybirds. The crate holds 33,000 individuals and constitutes a colony for five acres of melons or orchard infested with aphids (plant lice).

Inasmuch as the colonies in December and January are usually buried beneath several feet of snow, it would not be pos-

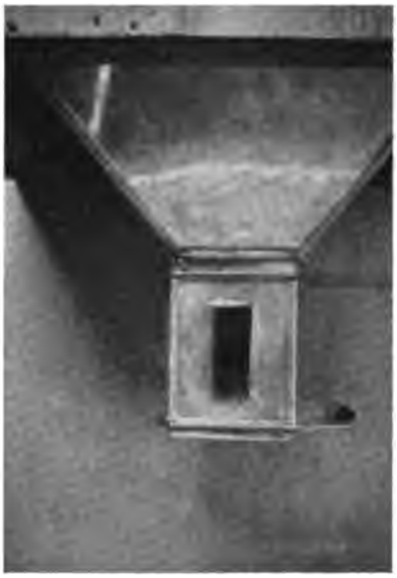

Fig. 11. The Ladybirds (*Hippodamia convergens*) are Measured in a Chute-like grain. The machine is operated with slides and counts 33,000 at each operation. They are packed in excelsior.

sible to find them but for the maps previously made on the cards in the manner already described. Provided with these maps, our field men know just where to look and lose no time. Their task, however, is difficult and laborious.

Usually once a week a mule pack train comes over the mountain trail to the camp to bring supplies and to carry away the sacks of beetles which have been accumulated. By this means the insects are conveyed to the nearest railway station, which is a distance of about 12 miles, where a small building has been rented and equipped as a packing house. Here the crop is cleaned, put up in suitable packages, and made ready for the long hibernation.

Between the time that the field men return from the preliminary location and the time the real collecting begins, the insectary force, assisted by the field men, are busily engaged in making the shipping crates. Each one is 13 inches long, eight inches wide, and 12 inches deep, covered on two sides with fine mesh wire netting and loosely filled with dry, clean excelsior. These receptacles are eventually to contain the ladybird crop, and when completed they are shipped to the packing house in the mountains.

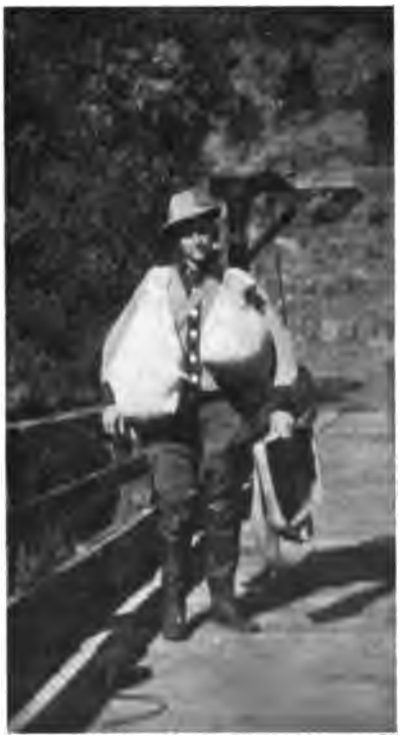

Fig. 12. A Collector Coming into Camp with a Day's Catch. Each collector carries a sieve and wears rubber boots to keep out the snow.

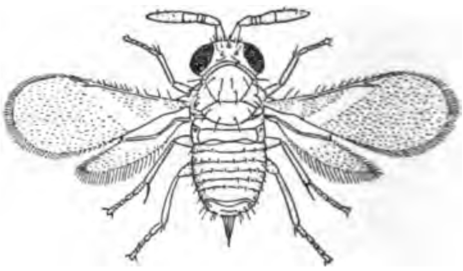

Fig. 13. The Golden Chalcid (***Aphelinus diaspidis*** Howard [Family Eulophidae]). The adults are exceedingly small and delicate, bright yellow insects. Common throughout the south part of California, though it probably occurs in many central and northern sections. Parasitic upon red scale (***Chrysamphalus aurantii***) and rose scale (***Aulacaspis rosae***).

During the packing season one man is left in charge of the packing house, who attends to recleaning and resacking the insects. He then proceeds with the next step in the packing process, which is to pour the bugs from the sacks into an ingenious machine which counts them: they are counted, that is to say, by measurement. Dropping into a sort of hopper, made of tin and glass, they are measured as they pass through this machine (which is operated by a system of slides) into the shipping crates before mentioned.

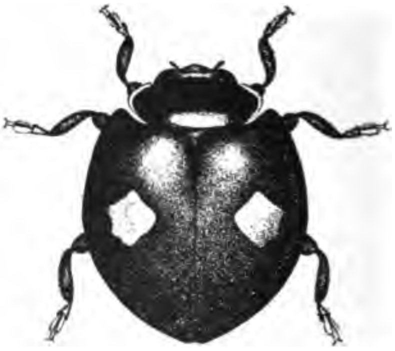

Fig. 14. The Two-Stabbed Ladybird Beetle (***Chilocorus bivulnerus*** Muls). The adults are broadly oval and about three-sixteenths of an inch long. The color is shiny black with two round blood-red spots upon the wing covers. The extreme margins of the prothorax are pale. The under side of the abdomen is red. The larvae are very shiny, dark in color, with a yellow tranverse band across the middle. This is one of the native ladybird beetles and is to be found in almost every part of California. The larvae and adults are voracious feeders upon the San Jose scale (***Aspidiotus perniciosus***), young of the black scale (***Saissetia oleae***), mealy bugs (***Pseudococcus citri*** and ***P. longispinus***), oyster shell scale (***Lepidosaphes ulmi***), European elm scale (***Gossyparia spuria***) and other scale insects.

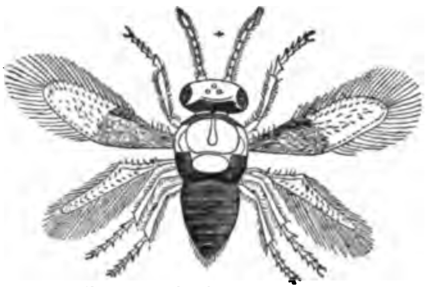

Fig. 15. The Purple Scale Parasite (*Aspidiotiphagus citrinus* Craw [Family Eulophidae]). An exceedingly small insect, almost microscopic in size, light and brownish yellow in color with wings, antennae and legs pale. Generally distributed throughout the purple scale-infested citrus districts in the southern part of California, but often limited or totally absent in certain localities. Works uncertainly but often very effectually on purple scale. *(Lepidosaphes beckii)* in small localities, but of little consequence in controlling this pest. It also works on yellow scale *(Chrysomphalus citrinus)*, red scale *(Chrysomphalus aurantii)*, and pernicious scale *(Aspidiotus Perniciosus)*.

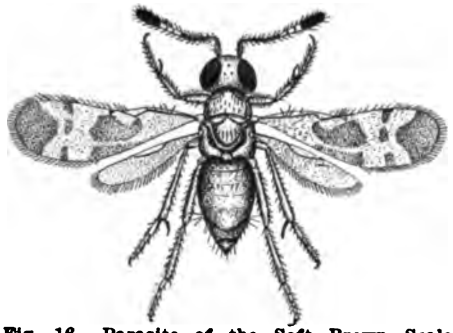

Fig. 16. Parasite of the Soft Brown Scale (*Encyrtus flavus* Howard [Family Encyrtidae]). A small parasite scarcely one-sixteenth of an inch long. The general color of the female is ochre; compound eyes brown; ocelli red; antennae yellow with tips black; the tips of the feet black. The basal third of the fore wings are clear with the remainder clouded with brown; the hind wings are clear. The males are considerably smaller than the females, and shiny metallic green in color with legs and antennae very light; wings clear with brown veins. Quite common throughout California, but especially abundant in the southern part. The soft brown scale (*Coccus hesperidum*) is often very effectually checked by its attacks.

The beetles are now in their final packages ready for distribution. But the time when they are needed will not arrive for six months, and meanwhile they must be kept alive and in first class condition. This, indeed, is the most difficult part of the whole business, the great problem being, as will be understood, to extend by artificial means, the natural hibernating period of the beetles in such a way that they may not lose any of their vitality.

In order that this may be accomplished they must be kept cold, without exposure to any marked change in temperature. If they are allowed to become warm, even for a little while, or moisture comes in contact with them, they will heat and cake into a solid mass, thus killing the entire colony in a remarkably short time.

A temperature slightly under 40 degrees Fahrenheit and plenty of ventilation is an absolute necessity, and the air must also be slightly moist, and the "crop" requires continual attention and at times the conditions must be changed quickly, or the entire lot will be lost.

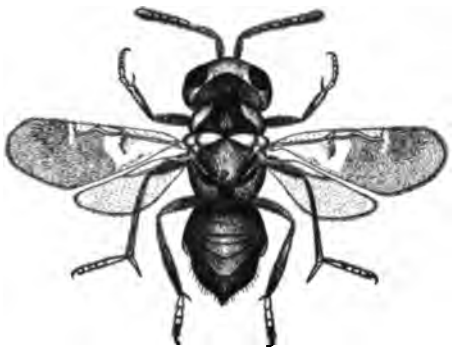

Fig. 17. Parasite of the Brown Apricot Scale (*Comys fusca* Howard [Family Encyrtidae]). The adults of this parasite are about one-eighth of an inch long and rich brown throughout in color. The wings are clouded with brownish markings, the bases remaining clear and when folded over the back, form a silverlike spot which is very noticeable when the insects are walking. The veins are black. The tips of the legs are yellowish with dark claws. One of the most common parasites occurring in all parts of California. Of all the internal parasites of scale insects this is one of the most efficient and is often quite a controlling factor in keeping down the brown apricot scale *(Leacnium corpi)*.

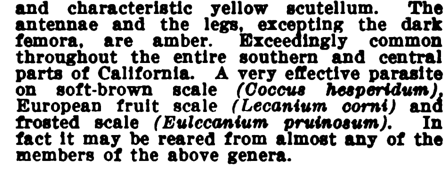

Fig. 18. Scale Parasite (*Coccophagus lecanii* Fitch [Family Eulophidae]). The adults are scarcely one-eighth of an inch long, dark bluish-black in color with a very noticeable and characteristic yellow scutellum. The antennae and the legs, excepting the dark femora, are amber. Exceedingly common throughout the entire southern and central parts of California. A very effective parasite on soft-brown scale *(Coccus hesperidum)*, European fruit scale *(Lecanium corni)* and frosted scale *(Eulecanium pruinosum)*. In fact it may be reared from almost any of the members of the above genera.

The insects are packed in colonies on an average of 33,000 to each colony. They are distributed in various ways; the small individual colonies being sent direct to the applicants, while large consignments intended to cover an entire district, such as the Imperial valley, are usually preceded by an agent from the Insectary, who figures out the acreage and prorates the amount that can be supplied to each grower or association, and personally attends to the distributing of the colonies.

Last season's crop (1912) was exceptionally large, and when massed at the state Insectary, just prior to the actual shipping season, this lot of insect friends, combined with all the other various species of beneficial insects propagated at the Insectary, constituted what was undoubtedly the largest number of beneficial insects ever assembled at one place in the history of the world.

Many other species of ladybirds, both native and imported, are propagated, collected and distributed into the various fruit growing sections of California to assist our growers in maintaining the continuous warfare against the inroads of destructive forms.

Other species belonging to the *Hymenoptera* (four-winged flies) and *Diptera* (two-winged flies) have proven of incalculable benefit to the grower of fruit in this state, as well as various species of Syrphus flies, Lace-wing flies and Tachinid flies.

A few of the more important species, with explanatory notes accompanied by illustrations, will give a general idea of the scope of the work and the variety of forms handled.

The work of propagating the various species calls for ingenuity of the highest order in every case. With no precedent to be guided by, methods and apparatus have to be improvised as we go along. The artificial propagation work has not resolved itself into any systematic arrangement, except: Try to produce artificially, conditions as near natural as possible in which to propagate your species.

While the work of the California State Insectary has made wonderful progress in the few years it has been commercially established, we are only at the threshold of the science and undoubtedly the future will show even greater progress than has the past, at least, that is the sincere wish of the first and only superintendent of the California State Insectary.

The Codling Moth Parasite
Caliephialtes messor

This insect is a member of the Ichneumonidae, a parasitic family of the Hy-

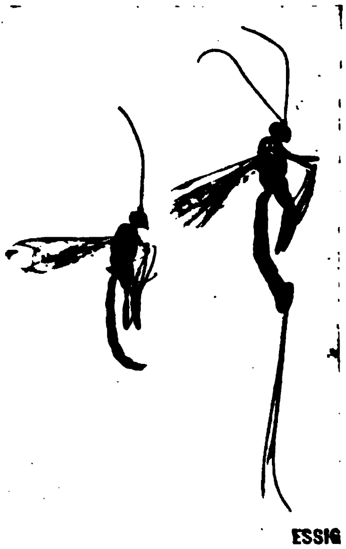

Fig. 19. The Codling Moth Parasite (*Calliephialtes messor* Grav. [Family Ichneumonidae]). The minute eggs deposited in the cocoons of the codling moth are shiny white, almost transparent in color and long and narrow, with one end slightly enlarged. The adults are very active, four-winged parasites, averaging three-eighths of an inch in length, exclusive of the ovipositor which is slightly longer than the body in the females. The males are slightly smaller. The general color is black with reddish-yellow legs. The female, with her long ovipositor, inserts an egg into the cocoon of the codling moth. In a few days this egg hatches into a small, legless grub, which begins to feed upon the larva. The subsequent development is very rapid and at the end of from nine to sixteen days the larva spins a cocoon within the old shell and after another like period emerges as an adult. The males emerge first and await the females, when mating occurs and the life cycle repeated; the females continually searching for cocoons into which to deposit their supply of eggs. This parasite was discovered in Southern Europe by George Compere, who collected large numbers and sent them to the State Insectary some eight years ago. During this period the Insectary has been breeding and sending it out to all parts of California where the codling moth is a factor in fruit growing. It was especially thoroughly distributed in the central and southern parts. The larvae enclosed in the cocoons are the only stages of the codling moth attacked. These are carefully searched out by the females which have a wonderful instinct to locate them as well as to ascertain whether they have already been parasitized or not.

menoptera. Introduced from Europe, where it is a very effective check upon the codling moth (*Carpcapsa pomonella*), the apple worm.

Ichneumon species are the most difficult to establish of all our beneficial species, often requiring several years to become numerous enough to be of great benefit.

A large stock of this particular species is reared each year and distributed throughout the apple and pear growing sections of the state.

This is one of the most interesting species propagated at the Insectary and we hope to eventually establish it in all sections of the state. Marked results are expected from its introduction as soon as it can adjust itself to our unnatural conditions that at present prevail in our commercial orchards.

EDWARD K. CARNES

December 20, 1912.

Note—The etchings and descriptions in fine print of insects in this article are from the Monthly Bulletin of the California Commission of Horticulture, Vol. II, Nos. 1 and 2. The photos are by the author, except Fig. 19, which is from the above source—Editor.

Birds Useful To Farm and Orchard

Entomologists estimate that insects yearly cause a loss of over $700,000,000 to the agriculture of the United States. Were it not for our birds, the loss would be very much greater, and it is doubtful if agriculture would be possible. A knowledge of the birds that protect the crops, is therefore as important as a knowledge of the pests that destroy them. Such knowledge is the more important, because some birds are injurious, some are partly useful and partly injurious, and others, a few, are always useful. For instance, there are insects that are parasitic and predatory, feeding upon other insects that injure the crops, but insectiverous birds destroy the useful and harmful alike. However, the good they do by the destruction of harmful insects, is far greater than the harm they do by the destruction of useful kinds. Even the birds called noxious, possess some redeeming qualities and traits. Thus the crow is mischievous in spring, pulling up the newly planted corn, and destroying the eggs of useful birds. But on the other hand, he eats insects, grubs, cut worms, meadow mice, gophers and other rodents, so that he is more useful than harmful.

Because their powers of flight enable them to gather rapidly at points where there are abnormal outbreaks of insects, birds are especially useful in protecting certain localities from scourges of grasshoppers and other pests; for an unusual number of insects in any particular locality attracts the birds, and they never leave until the insects are under control.

America is greatly favored in the number and character of its birds, which not only include some of the gems of the bird world, as warblers and humming birds, but on the whole embrace few destructive species. Not only do many birds satisfy our esthetic sense through their beautiful plumage and their sweet voices, but they are marvelously adapted to their respective fields of activity. No other creatures are so well fitted to capture flying insects as swallows, swifts and nighthawks. Among the avian ranks also are wrens, trim of body and agile of movement, that creep in and out of holes and crevices and explore rubbish heaps for hidden insects. The woodpecker, whose whole body exhibits wonderful adaptation of means to an end, is provided with strong claws for holding firmly when at work, a chisel-like bill driven by powerful muscles to dig out insects, and a long extensible tongue to still further explore the hidden retreats of insects and drag forth the concealed larvae, safe from other foes. The creepers, titmice, warblers, flycatchers, quails, doves, and other families have each their own special field of activity. However unlike they may be in appearance, structure, and habits, all are similar in one respect—they possess a never flagging appetite for insects and weed seeds.

One of the most useful groups of native birds is the sparrow family. While some of the tribe wear gay suits of many hues, most of the sparrows are clad in modest brown tints, and as they spend much of the time in grass and weeds are commonly overlooked. Unobtrusive as they are, they lay the farmer under a heavy debt of gratitude by their food habits, since their chosen fare consists largely of the seeds of weeds. Selecting a typical member of the group, the tree sparrow, for instance, one-fourth ounce of weed seed per day is a conservative estimate of the food of an adult. On this basis, in a large agricultural state like Iowa tree sparrows annually eat approximately 875 tons of weed seeds. Only the farmer, upon whose shoulders falls the heavy burden of freeing his land of noxious weeds, can realize what this vast consumption of weed seeds means in the saving and cost of labor. Some idea of the money value of this group of birds to the country may be gained from the statement that the total value of the farm products in the United States in 1910 reached the amazing sum of $8,926,000,000. If we estimate that the total consumption of weed seed by the combined members of the sparrow family resulted in a saving of only one per cent of the crops—not a violent assumption—the sum saved to farmers by these birds in 1910 was $89,260,000.

The current idea in relation to hawks and owls is erroneous. These birds are generally classed as thieves and robbers, whereas a large majority of them are the farmer's friends and spend the greater part of their long lives in pursuit of injurious insects and rodents. The hawks work by day, the owls chiefly by night, so that the useful activities of the two classes are continued practically throughout the 24 hours. As many as 100 grasshoppers have been found in the stomach of a Swainson's hawk, representing a single meal; and in the retreat of a pair of barn owls have been found more than 3,000 skulls, 97 per cent of which were of mammals, the bulk consisting of field mice, house mice and common rats. Nearly half a bushel of the remains of pocket gophers—animals which are very destructive in certain parts of the United States—was found near a nest of this species. The notable increase of noxious rodents during the last few years in certain parts of the United States and the consequent damage to crops are due in no small part to the diminished number of birds of prey, which formerly destroyed them and aided in keeping down their numbers. A few hawks are injurious, and the bulk of the depredations on birds and chickens chargeable against hawks is committed by three species — the cooper's hawk, the sharp-shinned hawk, and the goshawk. The farmer's boy should learn to know these daring robbers by sight, so as to kill them whenever possible.

From the foregoing it will at once appear that the practice of offering bounties indiscriminately for the heads of hawks and owls, as has been done by some States, is a serious mistake, the result being not only a waste of public funds but the destruction of valuable birds which can be replaced, if at all, only after the lapse of years.

As a rule birds do not live very long, but they live fast. They breathe rapidly and have a higher temperature and a more rapid circulation than other vertebrates. This is a fortunate circumstance, since to generate the requisite force to sustain their active bodies a large quantity of food is necessary, and as a matter of fact birds have to devote most of their waking hours to obtaining insects, seeds, berries, and other kinds of food. The activity of birds in the pursuit of insects is still further stimulated by the fact that the young of most species, even those which are by no means strictly insectivorous, require great quantities of animal food in the early weeks of existence, so that during the summer months—the flood time of insect life—birds are compelled to redouble their attacks on our insect foes to satisfy the wants of their clamorous young.

Field observations of the food habits of birds serve a useful purpose, but they are rarely accurate enough to be fully reliable. The presence of certain birds in a corn or wheat field or in an orchard is by no means proof, as is too often assumed, that they are devastating the grain or fruit. They may have been attracted by insects which, unknown to the farmer or orchardist, are fast ruining his crop. Hence it has been found necessary to examine the stomachs and crops of birds to ascertain definitely what and how much they eat. The Biological Survey has in this way examined upward of 50,000 birds, most of which have been obtained during the last 25 years from scientific collectors, for our birds are too useful to be sacrificed when it can possibly be avoided, even for the sake of obtaining data upon which to base legislation for their protection.

It is interesting to observe that hungry birds—and birds are hungry most of the time—are not content to fill their stomachs with insects or seeds, but after the stomach is stuffed until it will hold no more continue to eat till the crop or gullet also is crammed. It is often the case that when the stomach is opened and the contents piled up the pile is two or three times as large as the stomach was when filled. Birds may truly be said to have healthy appetites. To show the astonishing capacity of birds' stomachs and to reveal the extent to which man is indebted to birds for the destruction of noxious insects, the following facts are given as learned by stomach examinations made by assistants of the Biological Survey:

A tree swallow's stomach was found to contain 40 entire chinch bugs and fragments of many others, besides 10 other species of insects. A bank swallow in Texas devoured 68 cotton-boll weevils, one of the worst insect pests that ever invaded the United States and 35 cliff swallows had taken an average of 18 boll weevils each. Two stomachs of pine siskins from Haywards, Cal., contained 1,900 black olive scales and 300 plant lice. A killdeer's stomach taken in November in Texas contained over 300 mosquito larvae. A flicker's stomach held 28 white grubs. A nighthawk's stomach collected in Kentucky contained 34 May beetles, the adult form of white grubs. Another nighthawk from New York had eaten 24 clover-leaf weevils and 375 ants. Still another nighthawk had eaten 340 grasshoppers, 52 bugs, 3 beetles, 2 wasps and a spider. A boat-tailed grackle from Texas had eaten at one meal about 100 cotton bollworms, besides a few other insects. A ring-necked pheasant's crop from Washington contained 8,000 seeds of chickweed and a dandelion head. More than 72,000 seeds have been found in a single duck stomach taken in Louisiana in February.

A knowledge of his bird friends and enemies, therefore, is doubly important to the farmer and orchardist in order that he may protect the kinds that earn protection by their services and may drive away or destroy the others. At the present time many kinds of useful birds need direct intervention in their behalf as never before. The encroachments of civilization on timbered tracts and the methods of modern intensive cultivation by destroying or restricting breeding grounds of birds tend to diminish their ranks. The number of insect pests, on the other hand, is all the time increasing by leaps and bounds through importations from abroad and by migration from adjoining territories. Every effort, therefore, should be made to augment the numbers of our useful birds by protecting them from their enemies, by providing nesting facilities, and by furnishing them food in times of stress, especially in winter.

Important in this connection is the planting near the house and even in out-of-the-way places on the farm of various berry-bearing shrubs, many of which are ornamental, which will supply food when snow is on the ground. Other species which are not berry eaters, like the woodpeckers, nuthatches, creepers, and chickadees, can be made winter residents of many farms, even in the North, by putting out at convenient places a supply of suet, of which they and many other birds are very fond, even in summer. Hedges and thickets about the farm are important to furnish nesting sites and shelter both from the elements and from the numerous enemies of birds.

Few are aware of the difficulty often experienced by birds in obtaining water for drinking and bathing, and a constant supply of water near the farmhouse will materially aid in attracting birds to the neighborhood and in keeping them there, at least till the time of migration. Shallow trays of wood or metal admirably serve the purpose, especially as birds delight to bathe in them.

Considerable success has been met with in Germany and elsewhere in Europe by supplying artificial nest boxes for birds, and the same method of increasing the number of birds and attracting them to farms and orchards where their services are most needed should be extensively employed in this country. The experiment can the more easily be tried since several firms in the United States are now prepared to make and deliver boxes specially designed for martins, swallows, bluebirds, wrens, woodpeckers, and other species. The average farmer's boy, however, if provided with a few tools, is quite equal to the task of making acceptable boxes for the commoner species, which are far from fastidious as to the appearance of the box intended for their occupancy.

One of the worst foes of our native birds is the house cat, and probably none of our native wild animals destroys as many birds on the farm, particularly fledglings, as cats. The household pet is by no means blameless in this respect, for the bird-hunting instinct is strong even in the well-fed tabby; but much of the loss of our feathered life is attributable to the half-starved stray, which in summer is as much at home in the groves and fields as the birds themselves. Forced to forage for their own livelihood, these animals, which are almost as wild as the ancestral wildcat, inflict an appalling loss on our feathered allies and even on the smaller game birds like the woodcock and bobwhite. If cats are to find place in the farmer's household every effort should be made by careful feeding and watching them to insure the safety of the birds. The cat without a home should be mercifully put out of the way.

In the present article 50 of our commoner birds are discussed, including some that are destructive. They inhabit various parts of the country, and it is for the interest of the farmers of the respective localities to be familiar with them. The accounts of the birds' habits are necessarily brief, but they are believed to be sufficient to acquaint the reader with the most prominent characteristics of the several species, at least from the standpoint of their relation to man.

Bluebird

Sialia sialis

Length,* about six and one-half inches.

Range

Breeds in the United States (west to Arizona, Colorado, Wyoming, and Montana), Southern Canada, Mexico, and Gautemala; winters in the southern half of the Eastern United States and south to Gautemala.

Habits and Economic Status

The bluebird is one of the most familiar tenants of the farm and dooryard. This bird, like the robin, phoebe, house wren, and some swallows, is very domestic in its habits. Its favorite nesting sites are crannies in the farm buildings or boxes made for its use or natural cavities in old apple trees. For rent the bird pays amply by destroying insects, and it takes no toll from the farm crop. The bluebird's diet consists of 68 per cent of insects to 32 per cent of vegetable matter. The largest items of insect food are grasshoppers first and beetles next, while caterpillars stand third. All of these are harmful except a few of the beetles. The vegetable food consists chiefly of fruit pulp, only an insignificant portion of which is of cultivated varieties. Among wild fruits elderberries are the favorite. From the above it will be seen that the bluebird does no essential harm, but eats many harmful and annoying insects.

Robin

Planesticus migratorius

Length, 10 inches.

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* Measured from tip of bill to tip of tail.

Range

Breeds in the United States (except the Gulf states), Canada, Alaska, and Mexico; winters in most of the United States and south to Gautemala.

Habits and Economic Status

In the North and some parts of the West the robin is among the most cherished of our native birds. The robin is an omnivorous feeder, and its food includes many orders of insects, with no very pronounced preference for any. It is very fond of earthworms, but its real economic status is determined by the vegetable food, which amounts to about 58 per cent of all. The principal item is fruit, which forms more than 51 per cent of the total food. The fact that in the examination of over 1,200 stomachs the percentage of wild fruit was found to be 5 times that of the cultivated varieties suggests that berry-bearing shrubs, if planted near the orchard, will serve to protect more valuable fruits. The bird's general usefulness is such, however, that all reasonable means of protecting orchard fruit should be tried before killing the birds.

Russet-Backed Thrush

Hylocichla ustulata

Length, seven and one-fourth inches. Among thrushes having the top of head and tail nearly the same color as the back, this one is distinguished by its tawny eye ring and cheeks. The Pacific coast subspecies is russet brown above, while the other suspecies is the olive-backed thrush. The remarks below apply to the species as a whole.

Range

Breeds in the forested parts of Alaska and Canada and south to California, Colorado, Michigan, New York, West Virginia (mountains), and Maine; winters from Mexico to South America.

Habits and Economic Status

This is one of a small group of thrushes the members of which are by many ranked first among American songbirds. The several members resemble one another in size, plumage, and habits. While this thrush is very fond of fruit, its partiality for the neighborhood of streams keeps it from frequenting orchards far from water. It is most troublesome during the cherry season, when the young are in the nest. From this it might be inferred that the young are fed on fruit, but such is not the case. The adults eat fruit, but the nestlings, as usual, are fed mostly upon insects. Beetles constitute the largest item of animal food, and ants come next. Many caterpillars also are eaten. The great bulk of vegetable food consists of fruit, of which two-fifths is of cultivated varieties. Where these birds live in or near gardens or orchards, they may do considerable damage, but they are too valuable as insect destroyers to be killed if the fruit can be protected in any other way.

Ruby-Crowned Kinglet

Regulus calendula

Length, about four and one-fourth inches. Olive green above, soiled whitish below, concealed feathers on head (crest) bright red.

Range

Breeds in Southern Canada, Southern Alaska, and the higher mountains of the Western United States; winters in much of the United States and south to Gautemala.

Habits and Economic Status

In habits and haunts this tiny sprite resembles a chickadee. It is an active, nervous little creature, flitting hither and yon in search of food, and in spring stopping only long enough to utter its beautiful song, surprisingly loud for the size of the musician. Three-fourths of its food consists of wasps, bugs, and flies. Beetles are the only other item of importance (12 per cent). The bugs eaten by the kinglet are mostly small, but, happily, they are the most harmful kinds. Tree hoppers, leaf hoppers, and jumping plant lice are pests and often do great harm to trees and smaller plants, while plant lice and scale insects are the worst scourges of the fruit grower—in fact, the prevalence of the latter has almost risen to the magnitude of a national peril. It is these small and seemingly insignificant birds that most successfully attack and hold in check these insidious foes of horticulture. The vegetable food consists of seeds of poison ivy, or poison oak, a few weed seeds, and a few small fruits, mostly elderberries.

Chickadee

Penthestes atricapillus

Length, about five and one-fourth inches.

Range

Resident in the United States (except the southern half east of the plains), Canada and Alaska.

Habits and Economic Status

Because of its delightful notes, its confiding ways, and its fearlessness, the chickadee is one of our best-known birds. It responds to encouragement, and by hanging within its reach a constant supply of suet the chickadee can be made a regular visitor to the garden and orchard. Though insignificant in size, titmice are far from being so from the economic standpoint, owing to their numbers and activity. While one locality is being scrutinized for food by a larger bird, 10 are being searched by the smaller species. The chickadee's food is made up of insects and vegetable matter in the proportion of 7 of the former to 3 of the latter. Moths and caterpillars are favorites and form about one-third of the whole. Beetles, ants, wasps, bugs, flies, grasshoppers, and spiders make up the rest. The vegetable food is composed of seeds, largely those of pines, with a few of the poison ivy and some weeds. There are few more useful birds than the chickadees.

White-Breasted Nuthatch

Sitta carolinensis

Length, six inches. White below, above gray, with a black head.

Range

Resident in the United States, Southern Canada and Mexico.

Habits and Economic Status

This bird might readily be mistaken by a careless observer for a small woodpecker, but its note, an oft-repeated *yank*, is very unwoodpecker-like, and, unlike either woodpeckers or creepers it climbs downward as easily as upward and seems to set the laws of gravity at defiance. The name was suggested by the habit of wedging nuts, especially beechnuts, in the crevices of bark so as to break them open by blows from the sharp, strong bill. The nuthatch gets its living from the trunks and branches of trees, over which it creeps from daylight to dark. Insects and spiders constitute a little more than 50 per cent of its food. The largest items of these are beetles, moths, and caterpillars, with ants and wasps. The animal food is all in the bird's favor except a few ladybird beetles. More than half of the vegetable food consists of mast, i. e., acorns and other nuts or large seeds. One-tenth of the food is grain, mostly waste corn. The nuthatch does no injury, so far as known, and much good.

Brown Creeper

Certhia familiaris americana and other subspecies

Length five and one-half inches.

Range

Breeds from Nebraska, Indiana, North Carolina (mountains), and Massachusetts north to Southern Canada, also in the mountains of the Western United States, north to Alaska, south to Nicaragua; winters over most of its range.

Habits and Economic Status

Rarely indeed is the creeper seen at rest. It appears to spend its life in an incessant scramble over the trunks and branches of trees, from which it gets all its food. It is protectively colored so as to be practically invisible to its enemies and, though delicately built, possesses amazingly strong claws and feet. Its tiny eyes are sharp enough to detect insects so small that most other species pass them by, and altogether the creeper fills a unique place in the ranks of our insect destroyers. The food consists of minute insects and insects' eggs, also cocoons of tineid moths, small wasps, ants, and bugs, especially scales and plant lice, with some small caterpillars. As the creeper remains in the United States throughout the year, it naturally secures hibernating insects and insects' eggs, as well as spiders and spiders' eggs, that are missed by the summer birds. On its bill of fare we find no product of husbandry nor any useful insects.

House Wren

Troglodytes aedon

Length, four and three-fourths inches. The only one of our wrens with wholly whitish underparts that lacks a light line over the eye.

Range

Breeds throughout the United States (except the South Atlantic and Gulf states) and Southern Canada; winters in the Southern United States and Mexico.

Habits and Economic Status

The rich, bubbling song of the familiar little house wren is one of the sweetest associations connected with country and suburban life. Its tiny body, long bill, sharp eyes, and strong feet peculiarly adapt it for creeping into all sorts of nooks and crannies where lurk the insects it feeds on. A cavity in a fence post, a hole in a tree, or a box will be welcomed alike by this busybody as a nesting site; but since the advent of the quarrelsome English sparrow such domiciles are at a premium and the wren's eggs and family are safe only in cavities having entrances too small to admit the sparrow. Hence it behooves the farmer's boy to provide boxes the entrances to which are about an inch in diameter, nailing these under gables of barns and outhouses or in orchard trees. In this way the numbers of this useful bird can be increased, greatly to the advantage of the farmer. Grasshoppers, beetles, caterpillars, bugs, and spiders are the principal elements of its food. Cutworms, weevils, ticks, and plant lice are among the injurious forms eaten. The nestlings of house wrens consume great quantities of insects.

Brown Thrasher

Toxostoma rufum

Length, about 11 inches. Brownish red above, heavily streaked with black below.

Range

Breeds from the Gulf states to Southern Canada and west to Colorado, Wyoming, and Montana; winters in the southern half of the Eastern United States.

Habits and Economic Status

The brown thrasher is more retiring than either the mocking bird or catbird, but like them, is a splendid singer. Not infrequently, indeed, its song is taken for that of its more famed cousin, the mocking bird. It is partial to thickets and gets much of its food from the ground. Its search for this is usually accompanied by much scratching and scattering of leaves; whence its common name. Its call note is a sharp sound like the smacking of lips, which is useful in identifying this long-tailed, thicket-haunting bird, which does not much relish close scrutiny. The brown thrasher is not so fond of fruit as the catbird and mocker, but devours a much larger percentage of animal food. Beetles form one-half of the animal food, grasshoppers and crickets one-fifth, caterpillars, including cutworms, somewhat less than one-fifth, and bugs, spiders, and millipeds comprise most of the remainder. The brown thrasher feeds on such coleopterous pests as wire worms, May beetles, rice weevils, rose beetles, and figeaters. By its destruction of these and other insects, which constitute more than 60 per cent of its food, the thrasher much more than compensates for that portion (about one-tenth) of its diet derived from cultivated crops.

Catbird

Dumetella carolinensis

Length, about nine inches. The slaty gray plumage and black cap and tail are distinctive.

Range

Breeds throughout the United States west to New Mexico, Utah, Oregon and Washington, and in Southern Canada; winters from the Gulf states to Panama.

Habits and Economic Status

In many localities the catbird is one of the commonest birds. Tangled growths are its favorite nesting places and retreats, but berry patches and ornamental shrubbery are not disdained. Hence the bird is a familiar dooryard visitor. The bird has a fine song, unfortunately marred by occasional cat calls. With habits similar to those of the mocking bird and a song almost as varied, the catbird has never secured a similar place in popular favor. Half of its food consists of fruit, and the cultivated crops most often injured are cherries, strawberries, raspberries and blackberries. Beetles, ants, crickets and grasshoppers are the most important element of its animal food. The bird is known to attack a few pests, as cutworms, leaf beetles, clover-root curculio, and the periodical cicada, but the good it does in this way probably does not pay for the fruit it steals. The extent to which it should be protected may perhaps be left to the individual cultivator; that is, it should be made lawful to destroy catbirds that are doing manifest damage to crops.

Mocking Bird

Mimus polyglottos

Length, 10 inches. Most easily distinguished from the similarly colored loggerhead shrike by the absence of a conspicuous black stripe through the eye.

Range

Resident from Southern Mexico north to California, Wyoming, Iowa, Ohio and Maryland; casual farther north.

Habits and Economic Status

Because of its incomparable medleys and imitative powers, the mocking bird is the most renowned singer of the Western hemisphere. Even in confinement it is a masterly performer, and formerly thousands were trapped and sold for cage birds, but this reprehensible practice has been largely stopped by protective laws. It is not surprising, therefore, that the mocking bird should receive protection principally because of its ability as a songster and its preference for the vicinity of dwellings. Its place in the affections of the South is similar to that occupied by the robin in the North. It is well that this is true, for the bird appears not to earn protection from a strictly economic standpoint. About half of its diet consists of fruit, and many cultivated varieties are attacked, such as oranges, grapes, figs, strawberries, blackberries and raspberries. Somewhat less than a fourth of the food is animal matter, and grasshoppers are the largest single element. The bird is fond of cotton worms, and is known to feed also on the chinch bug, rice weevil and bollworm. It is unfortunate that it does not feed on injurious insects to an extent sufficient to offset its depredations on fruit.

Myrtle Warbler

Dendroica coronata

Length, five and one-half inches. The similarly colored Audubon's warbler has a yellow throat instead of a white one.

Range

Breeds throughout most of the forested area of Canada and south to Minnesota, Michigan, New York and Massachusetts; winters in the southern two-thirds of the United States and south to Panama.

Habits and Economic Status

This member of our beautiful wood warbler family, a family peculiar to America, has the characteristic voice, coloration and habits of its kind. Trim of form and graceful of motion, when seeking food it combines the methods of the wrens, creepers and flycatchers. It breeds only in the northern parts of the Eastern United States, but in migration it occurs in every patch of woodland and is so numerous that it is familiar to every observer. Its place is taken in the West by Audubon's warbler. More than three-fourths of the food of the myrtle warbler consists of insects, practically all of them harmful. It is made up of small beetles, including some weevils, with many ants and wasps. This bird is so small and nimble that it successfully attacks insects too minute to be prey for larger birds. Scales and plant lice form a very considerable part of its diet. Flies are the largest item of food; in fact, only a few flycatchers and swallows eat as many flies as this bird. The vegetable food (22 per cent) is made up of fruit and the seeds of poison oak or ivy, also the seeds of pine and of the bayberry.

Loggerhead Shrike
Lanius ludovicianus

Length, about nine inches. A gray, black and white bird, distinguished from the somewhat similarly colored mocking bird by the black stripe on side of head.

Range

Breeds throughout the United States, Mexico and Southern Canada; winters in the southern half of the United States and in Mexico.

Habits and Economic Status

The loggerhead shrike, or Southern butcher bird, is common throughout its range and is sometimes called "French mocking bird" from a superficial resemblance and not from its notes, which are harsh and unmusical. The shrike is naturally an insectivorous bird which has extended its bill of fare to include small mammals, birds and reptiles. Its hooked beak is well adapted to tearing its prey, while to make amends for the lack of talons it has hit upon the plan of forcing its victim, if too large to swallow, into the fork of a bush or tree, where it can tear it asunder. Insects, especially grasshoppers, constitute the larger part of its food, though beetles, moths, caterpillars, ants, wasps and a few spiders also are taken. While the butcher bird occasionally catches small birds, its principal vertebrate food is small mammals, as field mice, shrews, and moles, and when possible it obtains lizards. It habitually impales its surplus prey on a thorn, sharp twig, or barb of a wire fence.

Barn Swallow
Hirundo erythrogastra

Length, about seven inches. Distinguished among our swallows by deeply forked tail.

Range

Breeds throughout the United States (except the South Atlantic and Gulf states) and most of Canada; winters in South America.

Habits and Economic Status

This is one of the most familiar birds of the farm and one of the greatest insect destroyers. From daylight to dark on tireless wings it seeks its prey, and the insects destroyed are countless. Its favorite nesting site is a barn rafter, upon which it sticks its mud basket. Most modern barns are so tightly constructed that swallows cannot gain entrance, and in New England and some other parts of the country barn swallows are much less numerous than formerly. Farmers can easily provide for the entrance and exit of the birds and so add materially to their numbers. It may be well to add that the parasites that sometimes infest the nests of swallows are not the ones the careful housewife dreads, and no fear need be felt of the infestation spreading to the houses. Insects taken on the wing constitute the almost exclusive diet of the barn swallow. More than one-third of the whole consists of flies, including unfortunately some useful parasitic species. Beetles stand next in order and consist of a few weevils and many of the small dung beetles of the May beetle family that swarm over the pastures in the late afternoon. Ants amount to more than one-fifth of the whole food, while wasps and bees are well represented.

Purple Martin
Progne subis

Length, about eight inches.

Range

Breeds throughout the United States and Southern Canada, south to Central Mexico; winters in South America.

Habits and Economic Status

This is the largest as it is one of the most beautiful of the swallow tribe. It formerly built its nests in cavities of trees, as it still does in wild districts, but learning that man was a friend it soon adopted domestic habits. Its presence about the farm can often be secured by erecting houses suitable for nesting sites and protecting them from usurpation by the English sparrow, and every effort should be made to increase the number of colonies of this very useful bird. The boxes should be at a reasonable height, say 15 feet from the ground, and made inaccessible to cats. A colony of these birds on a farm makes great inroads upon the insect population, as the birds not only themselves feed upon insects but rear their young upon the same diet. Fifty years ago in New England it was not uncommon to see colonies of 50 pairs of martins, but most of them have now vanished for no apparent reason except that the martin houses have decayed and have not been renewed. More than three-fourths of this bird's food consists of wasps, bugs, and beetles, their importance being in the order given. The beetles include several species of harmful weevils, as the clover-leaf weevils and the nut weevils. Besides these are many crane flies, moths, May flies, and dragon flies.

Black-Headed Grosbeak

Zamelodia melanocephala

Length, about eight and one-fourth inches.

Range

Breeds from the Pacific coast to Nebraska and the Dakotas, and from Southern Canada to Southern Mexico; winters in Mexico.

Habits and Economic Status

The black-headed grosbeak takes the place in the West of the rosebreast in the East, and like it is a fine songster. Like it also the blackhead readily resorts to orchards and gardens and is common in agricultural districts. The bird has a very powerful bill and easily crushes or cuts into the firmest fruit. It feeds upon cherries, apricots and other fruits, and also does some damage to green peas and beans, but it is so active a foe of certain horticultural pests that we can afford to overlook its faults. Several kinds of scale insects are freely eaten, and one, the black olive scale, constitutes a fifth of the total food. In May many canker worms and codling moths are consumed, and almost a sixth of the bird's seasonal food consists of flower beetles, which do incalculable damage to cultivated flowers and to ripe fruit. For each quart of fruit consumed by the black-headed grosbeak it destroys in actual bulk more than one and one-half quarts of black olive scales and one quart of flower beetles, besides a generous quantity of codling moth pupae and cankerworms. It is obvious that such work as this pays many times over for the fruit destroyed.

Rose-Breasted Grosbeak

Zamelodia ludoviciana

Length, eight inches.

Range

Breeds from Kansas, Ohio, Georgia (mountains), and New Jersey, north to Southern Canada; winters from Mexico to South America.

Habits and Economic Status

This beautiful grosbeak is noted for its clear, melodious notes, which are poured forth in generous measure. The rosebreast sings even at midday during summer, when the intense heat has silenced almost every other songster. Its beautiful plumage and sweet song are not its sole claim on our favor, for few birds are more beneficial to agriculture. The rosebreast eats some green peas and does some damage to fruit. But this mischief is much more than balanced by the destruction of insect pests. The bird is so fond of the Colorado potato beetle that it has earned the name of "potato-bug bird," and no less than a tenth of the total food of the rosebreasts examined consists of potato beetles—evidence that the bird is one of the most important enemies of the pest. It vigorously attacks cucumber beetles and many of the scale insects. It proved an active enemy of the Rocky Mountain locust during that insect's ruinous invasions, and among the other pests it consumes are the spring and fall cankerworms, orchard and forest tent caterpillars, tussock, gipsy and brown-tail moths, plum curculio, army worm and chinch bug. In fact, not one of our birds has a better record.

Song Sparrow

Melospiza melodia

Length, about six and one-fourth inches. The heavily spotted breast with heavy central blotch is characteristic.

Range

Breeds in the United States (except the South Atlantic and Gulf states), Southern Canada, Southern Alaska, and Mexico; winters in Alaska and most of the United States southward.

Habits and Economic Status

Like the familiar little "chippy," the song sparrow is one of our most domestic species, and builds its nest in hedges or in garden shrubbery close to houses, whenever it is reasonably safe from the house cat, which, however, takes heavy toll of the nestlings. It is a true harbinger of spring, and its delightful little song is thrilled forth from the top of some green shrub in early March and April, before most of our other songsters have thought of leaving the sunny South. Song sparrows vary much in habits, as well as in size and coloration. Some forms live along streams bordered by deserts, others in swamps among bulrushes and tules, others in timbered regions, others on rocky barren hillsides, and still others in rich, fertile valleys. With such a variety of habitat, the food of the species naturally varies considerably. About three-fourths of its diet consists of the seeds of noxious weeds and one-fourth of insects. Of these, beetles, especially weevils, constitute the major portion. Ants, wasps, bugs (including the black olive scale), and caterpillars are also eaten. Grasshoppers are taken by the Eastern birds, but not by the Western ones.

Chipping Sparrow

Spizella passerina

Length, about five and one-fourth inches. Distinguished by the chestnut crown, black line through eye, and black bill.

Range

Breeds throughout the United States, south to Nicaragua, and north to Southern Canada; winters in the Southern United States and southward.

Habits and Economic Status

The chipping sparrow is very friendly and domestic, and often builds its nest in gardens and orchards or in the shrubbery close to dwellings. Its gentle and confiding ways endear it to all bird lovers. It is one of the most insectivorous of all the sparrows. Its diet consists of about 42 per cent of insects and spiders and 58 per cent of vegetable matter. The animal food consists largely of caterpillars, of which it feeds a great many to its young. Besides these, it eats beetles, including many weevils, of which one stomach contained 30. It also eats ants, wasps, and bugs. Among the latter are plant lice and black olive scales. The vegetable food is practically all weed seed. A nest with four young of this species was watched at different hours on four days. In the seven hours of observation 119 feedings were noted, or an average of 17 feedings per hour, or four and one-half feedings per hour to each nestling. This would give for a day of 14 hours at least 238 insects eaten by the brood.

White-Crowned Sparrow

Zonotrichia leucophrys

Length, seven inches. The only similar sparrow, the white-throat, has a yellow spot in front of eye.

Range

Breeds in Canada, the mountains of New Mexico, Colorado, Wyoming and Montana, and thence to the Pacific coast; winters in the southern half of the United States and Northern Mexico.

Habits and Economic Status

This beautiful sparrow is much more numerous in the Western than in the Eastern states, where, indeed, it is rather rare. In the East it is shy and retiring, but it is much bolder and more conspicuous in the far West and there often frequents gardens and parks. Like most of its family it is a seed eater by preference, and insects comprise very little more than seven per cent of its diet. Caterpillars are the largest item, with some beetles, a few ants and wasps, and some bugs, among which are black olive scales. The great bulk of the food, however, consists of weed seeds, which amount to 74 per cent of the whole. In California this bird is accused of eating the buds and blossoms of fruit trees, but buds or blossoms were found in only 30 out of

516 stomachs, and probably it is only under exceptional circumstances that it does any damage in this way. Evidently neither the farmer nor the fruit grower has much to fear from the white-crowned sparrow. The little fruit it eats is mostly wild, and the grain eaten is waste or volunteer.

English Sparrow

Passer domesticus

Length, about six and one-fourth inches. Its incessant chattering, quarrelsome disposition, and abundance and familiarity about human habitations distinguish it from our native sparrows.

Range

Resident throughout the United States and Southern Canada.

Habits and Economic Status

Almost universally condemned since its introduction into the United States, the English sparrow has not only held its own, but has ever increased in numbers and extended its range in spite of all opposition. Its habit of driving out or even killing more beneficial species and the defiling of buildings by its droppings and by its own unsightly structures, are serious objections to this sparrow. Moreover, in rural districts, it is destructive to grain, fruit, peas, beans and other vegetables. On the other hand, the bird feeds to some extent on a large number of insect pests, and this fact points to the need of a new investigation of the present economic status of the species, especially as it promises to be of service in holding in check the newly introduced alfalfa weevil, which threatens the alfalfa industry in Utah and neighboring states. In cities most of the food of the English sparrow is waste material secured from the streets.

Crow Blackbird

Quiscalus quiscula

Length, 12 inches. Shorter by at least three inches than the other grackles with trough-shaped tails. Black, with purplish, bluish and bronze reflections.

Range

Breeds throughout the United States west to Texas, Colorado and Montana, and in Southern Canada; winters in the southern half of the breeding range.

Habits and Economic Status

This blackbird is a beautiful species, and is well known from its habit of congregating in city parks and nesting there year after year. Like other species which habitually assemble in great flocks, it is capable of inflicting much damage on any crop it attacks, and where it is harmful a judicious reduction of numbers is probably sound policy. It shares with the crow and blue jay the evil habit of pillaging the nests of small birds of eggs and young. Nevertheless it does much good by destroying insect pests, especially white grubs, weevils, grasshoppers and caterpillars. Among the caterpillars are army worms and other cutworms. When blackbirds gather in large flocks, as in the Mississippi valley, they may greatly damage grain, either when first sown or when in the milk. In winter they subsist mostly on weed seed and waste grain.

Brewer's Blackbird

Euphagus cyanocephalus

Length, 10 inches. Its glossy purplish head distinguishes it from other blackbirds that do not show in flight a trough-shaped tail.

Range

Breeds in the West, east to Texas, Kansas and Minnesota, and north to Southern Canada; winters over most of the United States breeding range, south to Guatemala.

Habits and Economic Status

Very numerous in the West and in fall gathers in immense flocks, especially about barnyards and corrals. During the cherry season in California Brewer's blackbird is much in the orchards. In one case they were seen to eat freely of cherries, but when a neighboring fruit raiser began to plow his orchard almost every blackbird in the vicinity was upon the newly opened ground and close at the plowman's heels in its eagerness to get the insects exposed by the plow. Caterpillars and pupae form the largest item of animal food (about 12 per cent). Many of these are cutworms, and cotton bollworms or corn earworms were found in 10 stomachs and codling moth pupae in 11. Beetles constitute over 11 per cent of the food. The vegetable food is practically contained in three items—grain, fruit and weed seeds. Grain, mostly oats, amounts to 54 per cent; fruit, largely cherries, four per cent; and weed seeds, not quite nine per cent. The grain is probably mostly wild, volunteer or waste, so that the bird does most damage by eating fruit.

Bullock's Oriole

Icterus bullocki

Length, about eight inches. Our only oriole with top of head and throat black and cheeks orange.

Range

Breeds from South Dakota, Nebraska and Kansas to the Pacific ocean and from Southern Canada to Northern Mexico; winters in Mexico.

Habits and Economic Status

In the West this bird takes the place occupied in the East by the Baltimore oriole. In food, nesting habits, and song the birds are similar. Both are migratory and remain on their summer range only some five or six months. They take kindly to orchards, gardens, and the vicinity of farm buildings and often live in villages and city parks. Their diet is largely made up of insects that infest orchards and gardens. When fruit trees are in bloom they are constantly busy among the blossoms and save many of them from destruction. In the food of Bullock's oriole beetles amount to 35 per cent and nearly all are harmful. Many of these are weevils, some of which live upon acorns and other nuts. Ants and wasps amount to 15 per cent of the diet. The black olive scale was found in 45 of the 162 stomachs examined. Caterpillars, with a few moths and pupae, are the largest item of food and amount to over 41 per cent. Among these were codling moth larvae. The vegetable food is practically all fruit (19 per cent) and in cherry season consists largely of that fruit. Eating small fruits is the bird's worst trait, but it will do harm in this way only when very numerous.

Meadowlarks

Sturnella magna and Sturnella neglecta

Length, about 10¾ inches.

Range

Breed generally in the United States, Southern Canada, and Mexico to Costa Rica; winter from the Ohio and Potomac valleys and British Columbia southward.

Habits and Economic Status

Our two meadowlarks, though differing much in song, resemble each other closely in plumage and habits. Grassy plains and uplands covered with a thick growth of grass or weeds, with nearby water, furnish the conditions best suited to the meadowlark's taste. The song of the Western bird is loud, clear and melodious. That of its Eastern relative is feebler and loses much by comparison. In many localities the meadowlark is classed and shot as a game bird. From the farmer's standpoint this is a mistake, since its value as an insect eater is far greater than as a game bird. Both the bollweevil, the foe of the cotton grower, and the alfalfa weevil are among the beetles it habitually eats. Twenty-five per cent of the diet of this bird is beetles, half of which are predaceous ground beetles, accounted useful insects, and one-fifth are destructive weevils. Caterpillars form 11 per cent of the food and are eaten in every month in the year. Among these are many cutworms and the well known army worm. Grasshoppers are favorite food and are eaten in every month and almost every day. The vegetable food (24 per cent of the whole) consists of grain and weed seeds.

Red-Winged Blackbird

Agelaius phoeniceus

Length, about nine and one-half inches.

Range

Breeds in Mexico and North America south of the Barren Grounds; winters in southern half of United States and south to Costa Rica.

Habits and Economic Status

The prairies of the upper Mississippi valley, with their numerous sloughs and ponds, furnish ideal nesting places for redwings, and consequently this region has become the great breeding ground for the species. These prairies pour forth the vast flocks that play havoc with grainfields. East of the Appalachian range, marshes on the shores of lakes, rivers, and estuaries are the only available breeding sites and, as these are comparatively few and small, the species is much less abundant than in the West. Redwings are eminently gregarious, living in flocks and breeding in communities. The food of the redwing consists of 27 per cent animal matter and 73 per cent vegetable. Insects constitute practically one-fourth of the food. Beetles (largely weevils, a most harmful group) amount to 10 per cent. Grasshoppers are eaten in every month and amount to about five per cent. Caterpillars (among them the injurious army worm) are eaten at all seasons and aggregate six per cent. Ants, wasps, bugs, flies, dragon flies, and spiders also are eaten. The vegetable food consists of seeds, including grain, of which oats is the favorite, and some small fruits. When in large flocks this bird is capable of doing great harm to grain.

Bobolink

Dolichonyx oryzivorus

Length, about seven inches.

Range

Breeds from Ohio northeast to Nova Scotia, north to Manitoba, and northwest to British Columbia; winters in South America.

Habits and Economic Status

When American writers awoke to the beauty and attractiveness of our native birds, among the first to be enshrined in song and story was the bobolink. Few species show such striking contrasts in the color of the sexes, and few have songs more unique and whimsical. In its northern home the bird is loved for its beauty and its rich melody; in the South it earns deserved hatred by its destructiveness. Bobolinks reach the southeastern coast of the United States the last half of April just as rice is sprouting, and at once begin to pull up and devour the sprouting kernels. Soon they move on to their northern breeding grounds, where they feed upon insects, weed seeds, and a little grain. When the young are well on the wing, they gather in flocks with the parent birds and gradually move southward, being then generally known as reed birds. They reach the rice fields of the Carolinas about August 20, when the rice is in the milk. Then, until the birds depart for South America, planters and birds fight for the crop, and in spite of constant watchfulness and innumerable devices for scaring the birds a loss of 10 per cent of the rice is the usual result.

Common Crow

Corvus brachyrhynchos

Length, 19 inches.

Range

Breeds throughout the United States and most of Canada; winters generally in the United States.

Habits and Economic Status

The general habits of the crow are universally known. Its ability to commit such misdeeds as pulling corn and stealing eggs and fruit and to get away unscathed is little short of marvelous. Much of the crow's success in life is due to cooperation, and the social instinct of the species has its highest expression in the winter roosts, which are sometimes frequented by hundreds of thousands of crows. From these roosts daily flights of many miles are made in search of food. Injury to sprouting corn is the most frequent complaint against this species, but by coating the seed grain with coal tar most of this damage may be prevented. Losses of poultry and eggs may be averted by proper housing and the judicious use of wire netting. The insect food of the crow includes wireworms, cutworms, white grubs, and grasshoppers, and during outbreaks of these insects the crow renders good service. The bird is also an efficient scavenger. But chiefly because of its destruction of beneficial wild birds and their eggs the crow must be classed as a criminal, and a reduction in its numbers in localities where it is seriously destructive is justifiable.

California Jay

Aphelocoma californica

Length, 12 inches. Distinguished from other jays within its range by its decidedly whitish underparts and brown patch on the back.

Range

Resident in California, north to Southern Washington, and south to Southern Lower California.

Habits and Economic Status

This jay has the same general traits of character as the Eastern blue jay. He is the same noisy, rollicking fellow and occupies a corresponding position in bird society. Robbing the nests of smaller birds is a favorite pastime, and he is a persistent spy upon domestic fowls and well knows the meaning of the cackle of a hen. Not only does he steal eggs but he kills young chicks. The insect food of this jay constitutes about one-tenth of its annual sustenance. The inclusion of grasshoppers and caterpillars makes this part of the bird's food in its favor. But the remainder of its animal diet includes altogether too large a proportion of beneficial birds and their eggs, and in this respect it appears to be worse than its Eastern relative, the blue jay. While its vegetable food is composed largely of mast, at times its liking for cultivated fruit and grain makes it a most unwelcome visitor to the orchard and farm. In conclusion, it may be said that over much of its range this jay is too abundant for the best interests of agriculture and horticulture.

Blue Jay

Cyanocitta cristata

Length, 11½ inches. The brilliant blue of the wings and tail combined with the black crescent of the upper breast and the crested head distinguish this species.

Range

Resident in the Eastern United States and Southern Canada, west to the Dakotas, Colorado and Texas.

Habits and Economic Status

The blue jay is of a dual nature. Cautious and silent in the vicinity of its nest, away from it it is bold and noisy. Sly in the commission of mischief, it is ever ready to scream "thief" at the slightest disturbance. As usual in such cases, its remarks are applicable to none more than itself, a fact neighboring nest holders know to their sorrow, for during the breeding season the jay lays heavy toll upon the eggs and young of other birds, and in doing so deprives us of the services of species more beneficial than itself. Approximately three-fourths of the annual food of the blue jay is vegetable matter, the greater part of which is composed of mast, i. e., acorns, chestnuts, beechnuts, and the like. Corn is the principal cultivated crop upon which this bird feeds, but stomach analysis indicates that most of the corn taken is waste grain. Such noxious insects as wood-boring beetles, grasshoppers, eggs of various caterpillars, and scale insects constitute about one-fifth of its food.

Horned Lark

Otocoris alpestris

Length, about seven and three-fourths inches. The black mark across the breast and the small, pointed tufts of dark feathers above and behind the eyes distinguish the bird.

Range

Breeds throughout the United States (except the South Atlantic and Gulf states) and Canada; winters in all the United States except Florida.

Habits and Economic Status

Horned larks frequent the open country, especially the plains and deserts. They associate in large flocks, are hardy, apparently delighting in exposed situations in winter, and often nest before snow disappears. The flight is irregular and hesitating, but in the breeding season the males ascend high in air, singing as they go, and pitch to the ground in one thrilling dive. The preference of horned larks is for vegetable food, and about one-sixth of this is grain, chiefly waste. Some sprouting grain is pulled, but drilled grain is safe from injury. California horned larks take much more grain than the Eastern birds, specializing on oats, but this is accounted for by the fact that oats grow wild over much of the state. Weed seeds are the largest single element of food. The insect food, about 20 per cent of the whole, includes such pests as May beetles and their larvae (white grubs), leaf beetles, cloverleaf and clover-root weevils, the potato-stalk borer, nut weevils, billbugs, and the chinch bug. Grasshoppers are a favorite food, and cutworms are freely eaten. The horned larks, on the whole, may be considered useful birds.

Arkansas Kingbird

Tyrannus verticalis

Length, nine inches. The white edge of the feather on each side of the tail distinguishes this from all other fly catchers except the gray and salmon-colored scissortail of Texas.

Range

Breeds from Minnesota, Kansas and Texas to the Pacific ocean and from Northern Mexico to Southern Canada; winters from Mexico to Guatemala.

Habits and Economic Status

The Arkansas kingbird is not so domestic as its Eastern relative and seems to prefer the hill country with scattered oaks rather than the orchard or the vicinity of ranch buildings, but it sometimes places its rude and conspicuous nest in trees on village streets. The bird's yearly food is composed of 87 per cent animal matter and 13 per cent vegetable. The animal food is composed almost entirely of insects. Like the Eastern species, it has been accused of destroying honeybees to a harmful extent, and remains of honeybees were found to constitute five per cent of the food of the individuals examined, but nearly all those eaten were drones. Bees and wasps, in general, are the biggest item of food (38 per cent), grasshoppers and crickets stand next (20 per cent), and beetles, mostly of noxious species, constitute 14 per cent of the food. The vegetable food consists mostly of fruit, such as the elder and other berries, with a few seeds. This bird should be strictly preserved.

Kingbird

Tyrannus tyrannus

Length, about eight and one-half inches. The white lower surface and white-tipped tail distinguish this fly catcher.

Range

Breeds throughout the United States (except the southwestern part) and Southern Canada; winters from Mexico to South America.

Habits and Economic Status

The kingbird is a pronounced enemy of hawks and crows, which it vigorously attacks at every opportunity, thereby affording efficient protection to nearby poultry yards and young chickens at large. It loves the open country and is especially fond of orchards and trees about farm buildings. No less than 85 per cent of its food consists of insects, mostly of a harmful nature. It eats the common rose chafer or rose bug, and more remarkable still it devours blister beetles freely. The bird has been accused of eating honeybees to an injurious extent, but there is little ground for the accusation, as appears from the fact that examination of 634 stomachs showed only 61 bees in 22 stomachs. Of these 51 were useless drones. On the other hand, it devours robber flies, which catch and destroy honeybees. Grasshoppers and crickets, with a few bugs and some cut worms, and a few other insects, make up the rest of the animal food. The vegetable food consists of fruit and a few seeds. The kingbird deserves full protection.

Nighthawk

Chordeiles virginianus

Length, 10 inches. Not to be confused with the whippoorwill. The latter lives in woodland and is chiefly nocturnal. The nighthawk often flies by day, when the white bar across the wing and its nasal cry are distinguishing.

Range

Breeds throughout most of the United States and Canada; winters in South America.

Habits and Economic Status

The skillful evolutions of a company of nighthawks as the birds gracefully cleave the air in intersecting circles is a sight to be remembered. So expert are they on the wing that no insect is safe from them, even the swift dragonfly being captured with ease. Unfortunately their erratic flight tempts men to use them for targets, and this inexcusable practice is seriously diminishing their numbers, which is deplorable, since no birds are more useful. This species makes no nest, but lays its two spotted eggs on the bare ground, sometimes on the gravel roof of the city house. The nighthawk is a voracious feeder and is almost exclusively insectivorous. Some stomachs contained from 30 to 50 different kinds of insects, and more than 600 kinds have been identified from the stomachs thus far examined. From 500 to 1,000 ants are often found in a stomach. Several species of mosquitoes, including *Anopheles*, the transmitter of malaria, are eaten. Other well known pests destroyed by the nighthawk are the Colorado potato beetle, cucumber beetles, chestnut, rice, clover-leaf and cotton-boll weevils, billbugs, bark beetles, squash bugs, and moths of the cotton worm.

Flicker

Colaptes auratus

Length, 13 inches. The yellow under surface of the wing, yellow tail shafts, and white rump are characteristic.

Range

Breeds in the Eastern United States west to the plains and in the forested parts of Canada and Alaska; winters in most of the Eastern United States.

Habits and Economic Status

The flicker inhabits the open country rather than the forest and delights in park-like regions where trees are numerous and scattered. It nests in any large cavity in a tree and readily appropriates an artificial box. It is possible, therefore, to insure the presence of this useful bird about the farm and to increase its numbers. It is the most terrestrial of our woodpeckers and procures much of its food from the ground. The largest item of animal food is ants, of which the flicker eats more than any other common birds. Ants were found in 524 of the 684 stomachs examined and 98 stomachs contained no other food. One stomach contained over 5,000 and two others held over 3,000 each. While bugs are not largely eaten by the flicker, one stomach contained 17 chinch bugs. Wild fruits are next to ants in importance in the flicker's dietary. Of these sour gum and wild black cherry stand at the head. The food habits of this bird are such as to recommend it to complete protection.

Yellow-Bellied Sapsucker

Sphyrapicus varius

Length, about eight and one-half inches. Only woodpecker having top of head from base of bill red, combined with a black patch on breast.

Range

Breeds in northern half of the United States and southern half of Canada; winters in most of the states and south to Costa Rica.

Habits and Economic Status

The yellow-bellied sapsucker is rather silent and suspicious and generally manages to have a tree between himself and the observer. Hence the bird is much better known by its works than its appearance. The regular girdles of holes made by this bird are common on a great variety of trees; in all about 250 kinds are known to be attacked. Occasionally young trees are killed outright, but more loss is caused by stains and other blemishes in the wood which result from sapsucker punctures. These blemishes, which are known as bird pecks, are especially numerous in hickory, oak, cypress and yellow poplar. Defects due to sapsucker work cause an annual loss to the lumber industry estimated at $1,250,000. The food of the yellow-bellied sapsucker is about half animal and half vegetable. Its fondness for ants counts slightly in its favor. It eats also wasps, beetles (including, however, very few wood-boring species), bugs, and spiders. The two principal components of the vegetable food are wild fruits of no importance and cambium (the layer just beneath the bark of trees). In securing the cambium the bird does the damage above described. The yellow-bellied sapsucker, unlike other woodpeckers, thus does comparatively little good and much harm.

Downy Woodpecker

Dryobates pubescens

Length, six inches. Our smallest woodpecker; spotted with black and white. Dark bars on the outer tail feathers distinguish it from the similarly colored but larger hairy woodpecker.

Range

Resident in the United States and the forested parts of Canada and Alaska.

Habits and Economic Status

This woodpecker is commonly distributed, living in woodland tracts, orchards and gardens. The bird has several characteristic notes, and, like the hairy woodpecker, is fond of beating on a dry resonant tree branch a tattoo which to appreciative ears has the quality of woodland music. In a hole excavated in a dead branch the downy woodpecker lays four to six eggs. This and the hairy woodpecker are among our most valuable allies, their food consisting of some of the worst foes of orchard and woodland, which the woodpeckers are especially equipped to dig out of dead and living wood. In the examination of 723 stomachs of this bird, animal food, mostly insects, was found to constitute 76 per cent of the diet and vegetable matter 24 per cent. The animal food consists largely of beetles that bore into timber or burrow under the bark. Caterpillars amount to 16 per cent of the food and include many especially harmful species. Grasshopper eggs are freely eaten. The vegetable food of the downy woodpecker consists of small fruit and seeds, mostly of wild species. It distributes seeds of poison ivy, or poison oak, which is about the only fault of this very useful bird.

Yellow-Billed Cuckoo

Coccyzus americanus

Length, about 12 inches. The yellow lower part of the bill distinguishes this bird from its near relative, the black-billed cuckoo.

Range

Breeds generally in the United States and Southern Canada; winters in South America.

Habits and Economic Status

This bird lives on the edges of woodland, in groves, orchards, parks, and even in shaded village streets. It is sometimes known as rain crow, because its very characteristic notes are supposed to foretell rain. The cuckoo has sly, furtive ways as it moves among the bushes or flits from tree to tree, and is much more often seen than heard. Unlike its European relative, it does not lay its eggs in other birds' nests, but builds a nest of its own. This is, however, a rather crude and shabby affair—hardly more than a platform of twigs sufficient to hold the greenish eggs. The cuckoo is extremely useful because of its insectivorous habits, especially as it shows a marked preference for the hairy caterpillars, which few birds eat. One stomach that was examined contained 250 American tent caterpillars; another, 217 fall webworms. In places where tent caterpillars are abundant they seem to constitute a large portion of the food of this and the black-billed cuckoo.

Screech Owl

Otus asio

Length, about eight inches. Our smallest owl with ear tufts. There are two distinct phases of plumage, one grayish and the other bright rufous.

Range

Resident throughout the United States, Southern Canada, and Northern Mexico.

Habits and Economic Status

The little screech owl inhabits orchards, groves and thickets, and hunts for its prey in such places as well as along hedgerows and in the open. During warm spells in winter it forages quite extensively and stores up in some hollow tree considerable quantities of food for use during inclement weather. Such larders frequently contain enough mice or other prey to bridge over a period of a week or more. With the exception of the burrowing owl it is probably the most insectivorous of the nocturnal birds of prey. It feeds also upon small mammals, birds, reptiles, batrachians, fish, spiders, crawfish, scorpions and earthworms. Grasshoppers, ground-dwelling beetles, crickets, and caterpillars are its favorites among insects, as are field mice among mammals and sparrows among birds. Out of 324 stomachs examined, 169 were found to contain insects; 142, small mammals; 56, birds; and 15, crawfish. The screech owl should be encouraged to stay near barns and outhouses, as it will keep in check house mice and wood mice, which frequent such places.

Barn Owl

Aluco pratincola

Length, about 17 inches. Facial disk not circular as in our other owls; plumage above, pale yellow; beneath, varying from silky white to pale bright tawny.

Range

Resident in Mexico, in the Southern United States, and north to New York, Ohio, Nebraska and California.

Habits and Economic Status

The barn owl, often called monkey-faced owl, is one of the most beneficial of the birds of prey, since it feeds almost exclusively on small mammals that injure farm produce, nursery, and orchard stock. It hunts principally in the open and consequently secures such mammals as pocket gophers, field mice, common rats, house mice, harvest mice, kangaroo rats and cotton rats. It occasionally captures a few birds and insects. At least a half bushel of the remains of pocket gophers have been found in the nesting cavity of a pair of these birds. Remembering that a gopher has been known in a short time to girdle seven apricot trees worth $100 it is hard to overestimate the value of the service of a pair of barn owls. 1,247 pellets of the barn owl collected from Smithsonian towers contained 3,100 skulls, of which 3,004, or 97 per cent, were of mammals; 92, or three per cent, of birds; and four were of frogs. The bulk consisted of 1,987 field mice, 656 house mice, and 210 common rats. The birds eaten were mainly sparrows and blackbirds. This valuable owl should be rigidly protected throughout its entire range.

Sparrow Hawk

Falco sparverius

Length, about 10 inches. This is one of the best known and handsomest, as well as the smallest, of North American hawks.

Range

Breeds throughout the United States, Canada and Northern Mexico; winters in the United States and south to Gautemala.

Habits and Economic Status

The sparrow hawk, which is a true falcon, lives in the more open country and builds its nest in hollow trees. It is abundant in many parts of the West, where telegraph poles afford it convenient perching and feeding places. Its food consists of insects, small mammals, birds, spiders and reptiles. Grasshoppers, crickets, and terrestrial beetles and caterpillars make up considerably more than half its subsistence, while field mice, house mice, and shrews cover fully 25 per cent of its annual supply. The balance of the food includes birds, reptiles, and spiders. Contrary to the usual habits of the species, some individuals during the breeding season capture nestling birds for food for their young and create considerable havoc among the songsters of the neighborhood. In agricultural districts when new ground is broken by the plow, they sometimes become very tame, even alighting for an instant under the horses in their endeavor to seize a worm or insect. Out of 410 stomachs examined, 314 were found to contain insects; 129, small mammals; and 70, small birds. This little falcon renders good service in destroying noxious insects and rodents and should be encouraged and protected.

Red-Tailed Hawk

Buteo borealis

Length, about two feet. One of our largest hawks; adults with tail reddish brown.

Range

Breeds in the United States, Mexico, Costa Rica, Canada, and Alaska; winters generally in the United States and south to Gautemala.

Habits and Economic Status

The red-tailed hawk, or "hen hawk," as it is commonly called, is one of the best known of all our birds of prey, and is a widely distributed species of great economic importance. Its habit of sitting on some prominent limb or pole in the open, or flying with measured wing beat over prairies and sparsely wooded areas on the lookout for its favorite prey, causes it to be noticed by the most indifferent observer. Although not as omnivorous as the red-shouldered hawk, it feeds on a variety of food, as small mammals, snakes, frogs, insects, birds, crawfish, centipedes, and even carrion. In regions where rattlesnakes abound it destroys considerable numbers of the reptiles. Although it feeds to a certain extent on poultry and birds, it is nevertheless entitled to general protection on account of the insistent warfare it wages against field mice and other small rodents and insects that are so destructive to young orchards, nursery stock, and farm produce. Out of 530 stomachs examined, 457, or 85 per cent, contained the remains of mammal pests such as field mice, pine mice, rabbits, several species of ground squirrels, pocket gophers, and cotton rats, and only 62 contained the remains of poultry or game birds.

Cooper's Hawk

Accipiter cooperi

Length, about 15 inches. Medium sized, with long tail and short wings, and without the white patch on rump which is characteristic of the marsh hawk.

Range

Breeds throughout most of the United States and Southern Canada; winters from the United States to Costa Rica.

Habits and Economic Status

The Cooper's hawk, or "blue darter," as it is familiarly known throughout the South, is preeminently a poultry and bird-eating species, and its destructiveness in this direction is surpassed only by that of its larger congener, the goshawk, which occasionally in autumn and winter enters the United States from the North in great numbers. The almost universal prejudice against birds of prey is largely due to the activities of these two birds, assisted by a third, the sharp-shinned hawk, which in habits and appearance might well pass for a small Cooper's hawk. These birds usually approach under cover and drop upon unsuspecting victims, making great inroads upon poultry yards and game coverts favorably situated for this style of hunting. Out of 123 stomachs examined, 38 contained the remains of poultry and game birds, 66 the remains of other birds, and 12 the remains of mammals. Twenty-eight species of wild birds were identified in the above-mentioned material. This destructive hawk, together with its two near relatives, should be destroyed by every possible means.

Mourning Dove

Zenaidura macroura

Length, 12 inches. The dark spot on the side of the neck distinguishes this bird from all other native doves and pigeons except the white-winged dove. The latter has the upper third of wing white.

Range

Breeds throughout the United States and in Mexico, Gautemala, and Southern Canada; winters from the Central United States to Panama.

Habits and Economic Status

The food of the mourning dove is practically all vegetable matter (over 99 per cent), principally seeds of plants, including grain. Wheat, oats, rye, corn, barley, and buckwheat were found in 150 out of 237 stomachs, and constituted 32 per cent of the food. Three-fourths of this was waste grain picked up after harvest. The principal and almost constant diet is weed seeds, which are eaten throughout the year and constitute 64 per cent of the entire food. In one stomach were found 7,500 seeds of yellow wood sorrel, in another 6,400 seeds of barn grass or foxtail, and in a third 2,600 seeds of slender paspalum, 4,820 of orange hawk weed, 950 of hoary vervain, 120 of Carolina cranesbill, 50 of yellow wood sorrel, 620 of panic grass, and 40 of various other weeds. None of these are useful, and most of them are troublesome weeds. The dove does not eat insects or other animal food. It should be protected in every possible way.

Ruffed Grouse

Bonasa umbellus

Length, 17 inches. The broad black band near tip of tail distinguishes this from other grouse.

Range

Resident in the northern two-thirds of the United States and in the forested parts of Canada.

Habits and Economic Status

The ruffed grouse, the famed drummer and finest game bird of the northern woods, is usually wild and wary and under reasonable protection well withstands the attacks of hunters. Moreover, when reduced in numbers, it responds to protection in a gratifying manner and has proved to be well adapted to propagation under artificial conditions. Wild fruits, mast, and browse make up the bulk of the vegetable food of this species. It is very fond of hazelnuts, beechnuts, chestnuts and acorns, and it eats practically all kinds of wild berries and other fruits. Nearly 60 kinds of fruits have been identified from the stomach contents examined. Various weed seeds also are consumed. Slightly more than 10 per cent of the food consists of insects, about half being beetles. The most important pests devoured are the potato beetle, clover-root weevil, the pale-striped flea beetle, grapevine leaf beetle, May beetles, grasshoppers, cotton worms, army worms, cutworms, the red-humped apple worm, and sawfly larvae. While the economic record of the ruffed grouse is fairly commendable, it does not call for more stringent protection than is necessary to maintain the species in reasonable numbers.

Bobwhite

Colinus virginianus

Length, 10 inches. Known everywhere by the clear whistle that suggests its name.

Range

Resident in the United States east of the plains; introduced in many places in the West.

Habits and Economic Status

The bobwhite is loved by every dweller in the country and is better known to more hunters in the United States than any other game bird. It is no less appreciated on the table than in the field, and in many states has unquestionably been hunted too closely. Fortunately it seems to be practicable to propagate the bird in captivity, and much is to be hoped for in this direction. Half the food of this quail consists of weed seeds, almost a fourth of grain, and about a tenth of wild fruits. Although thus eating grain, the bird gets most of it from stubble. Fifteen per cent of the bobwhite's food is composed of insects, including several of the most serious pests of agriculture. It feeds freely upon Colorado potato beetles and chinch bugs; it devours also cucumber beetles, wireworms, billbugs, clover-leaf weevils, cotton-boll weevils, army worms, bollworms, cutworms, and Rocky Mountain locusts. Take it all in all, bobwhite is very useful to the farmer, and while it may not be necessary to remove it from the list of game birds every farmer should see that his own farm is not depleted by eager sportsmen.

Kildeer

Oxyechus vociferus

Length, 10 inches. Distinguished by its piercing and oft-repeated cry—*kildee.*

Range

Breeds throughout the United States and most of Canada; winters from Central United States to South America.

Habits and Economic Status

The killdeer is one of the best known of the shorebird family. It often visits the farmyard and commonly nests in pastures or cornfields. It is rather suspicious, however, and on being approached takes flight with loud cries. It is noisy and restless, but fortunately most of its activities result in benefit to man. The food is of the same general nature as that of the upland plover, but is more varied. The killdeer feeds upon beetles, grasshoppers, caterpillars, ants, bugs, caddis flies, dragon flies, centipedes, spiders, ticks, oyster worms, earthworms, snails, crabs and other crustacea. Among the beetles consumed are such pests as the alfalfa weevil, cotton-boll weevil, clover-root weevil, clover-leaf weevil, pine weevil, billbugs, white grubs, wireworms, and leaf beetles. The bird also devours cotton worms, cotton cutworms, horseflies, mosquitoes, cattle ticks, and crawfish. One stomach contained hundreds of larvae of the saltmarsh mosquito, one of the most troublesome species. The killdeer preys extensively upon insects that are annoying to man and injurious to his stock and crops, and this should be enough to remove it from the list of game birds and insure its protection.

Upland Plover

Bartramia longicauda

Length, 12 inches. The only plainly colored shorebird which occurs east of the plains and inhabits exclusively dry fields and hillsides.

Range

Breeds from Oregon, Utah, Oklahoma, Indiana and Virginia, north to Alaska; winters in South America.

Habits and Economic Status

This, the most terrestrial of our waders, is shy and wary, but it has the one weakness of not fearing men on horseback or in a vehicle. One of these methods of approach, therefore, is nearly always used by the sportsman, and, since the bird is highly prized as a table delicacy, it has been hunted to the verge of extermination. As the upland plover is strictly beneficial, it should no longer be classed as a game bird and allowed to be shot. Ninety-seven per cent of the food of this species consists of animal forms, chiefly of injurious and neutral species. The vegetable food is mainly weed seeds. Almost half of the total subsistence is made up of grasshoppers, crickets and weevils. Among the weevils eaten are the cotton-boll weevil, greater and lesser clover-leaf weevils, cowpea weevils, and billbugs. This bird devours also leaf beetles, wire worms, white grubs, army worms, cotton worms, cotton cutworms, sawfly larvae, horseflies, and cattle ticks. In brief, it injures no crop, but consumes a host of the worst enemies of agriculture.

Black Tern

Hydrochelidon nigra surinamensis

Length, 10 inches. In autumn occurs as a migrant on the east coast of the United States, and then is in white and gray plumage. During the breeding season it is confined to the interior, is chiefly black, and is the only dark tern occurring inland.

Range

Breeds from California, Colorado, Missouri, and Ohio, north to Central Canada; winters from Mexico to South America; migrant in the Eastern United States.

Habits and Economic Status

This tern, unlike most of its relatives, passes much of its life on fresh-water lakes and marshes of the interior. Its nests are placed among the tules and weeds, on floating vegetation, or on muskrat houses. It lays from two to four eggs. Its food is more varied than that of any other tern. So far as known it preys upon no food fishes, but feeds extensively upon such enemies of fish as dragon fly nymphs, fish-eating beetles, and crawfishes. Unlike most of its family, it devours a great variety of insects, many of which it catches as it flies. Dragon flies, May flies, grasshoppers, predaceous diving beetles, scarabaeid beetles, leaf beetles, gnats, and other flies are the principal kinds preyed upon. Fishes of little economic value, chiefly minnows and mummichogs, were found to compose only a little more than 19 per cent of the contents of 145 stomachs. The great consumption of insects by the black tern places it among the beneficial species worthy of protection.

Franklin's Gull

Larus franklini

Length, 15 inches. During its residence in the United States Franklin's gull is practically confined to the interior and is the only inland gull with black head and red bill.

Range

Breeds in the Dakotas, Iowa, Minnesota and the neighboring parts of Southern Canada; winters from the Gulf coast to South America.

Habits and Economic Status

Nearly all of our gulls are coast-loving species and spend comparatively little of their time in fresh water, but Franklin's is a true inland gull. Extensive marshes bordering shallow lakes are its chosen breeding grounds, and as many such areas are being reclaimed for agricultural purposes it behooves the tillers of the soil to protect this valuable species. When undisturbed this gull becomes quite fearless and follows the plowman to gather the grubs and worms from the newly turned furrows. It lives almost exclusively upon insects, of which it consumes great quantities. Its hearty appetite is manifest from the contents of a few stomachs: A, 327 nymphs of dragon flies; B, 340 grasshoppers, 52 bugs, three beetles, two wasps, and one spider; C, 82 beetles, 87 bugs, 984 ants, one cricket, one grasshopper, and two spiders. About four-fifths of the total food is grasshoppers, a strong point in favor of this bird. Other injurious creatures eaten are billbugs, squash bugs, leaf hoppers, click beetles (adults of wire worms), May beetles (adults of white grubs), and weevils. Franklin's gull is probably the most beneficial bird of its group.

Henry W. Henshaw,
Washington, D. C.

The above descriptions are taken from U. S. Dept. Agri. Farm. Bul. 513. Other references to Government literature are:
Farm. Buls. 54, 497; Biological Survey Buls. 3, 9, 13, 15, 21, 28, 24, 30, 32, 34, 37, 39, 44. Dept. Agri. Yr. Book 1895.

Blackberry

Anyone who is familiar with farming conditions in the Eastern states knows by experience that the blackberry is one of the most common and one of the most tenacious of American native fruits. In Tennessee, Virginia, West Virginia, Kentucky, Pennsylvania, and other states, they spring up in abandoned fields and are difficult to eradicate.

The leading representative of this group is *Rubus nigrobaccus*.

All varieties change rapidly under cultivation and are, therefore, being rapidly improved. The blackberry thrives best usually on a northern slope, on heavy loamy soil, retentive of moisture. If the soil is rich in nitrogenous foods it tends to heavy wood growth, and but little fruit; if, however, there is little humus in the soil, it tends to fruit and less wood growth. In this particular it follows the law of most other fruits, for this is true of peaches, pears, apples and plums, as well as of berries.

Propagation

Propagation is almost always by means of sprouts or suckers that spring up from the roots. These grow in great abundance and when not desired for propagation are a hindrance, causing considerable work to keep them down. They also take strength from the parent stock and prevent the best development of the fruit. If the finest fruit is desired these suckers must be kept down; if suckers are desired for the market, they injure the fruit just the same; but the grower will decide whether his profits come mostly from fruits or plants and will give the preference to that which seems most valuable.

Medicinal Qualities

Blackberries are esteemed for their tendency to counteract bowel trouble, chronic diarrhoea, and were formerly used extensively for this purpose.

Planting

The setting of blackberries is not a difficult task. The first thing to do is to determine whether they are to be set in rows, or in squares, which some call the check system. This question would probably be determined by the contour of the land on which the orchard was to be located. If the land is rough, it may be found impracticable to use the check system in cultivating; but if it is smooth or level so that it can be cultivated both ways, the check system is, to our mind, preferable. The row system consists of setting the plants in rows, from five to ten feet apart, and the plants from three to five feet apart in the row. The check system is one in which the plants are set five to seven feet apart each way. The distances apart should be determined largely by the nature of the plants. Some varieties tend to grow large and tall while others grow short and stocky. It is practicable to put twice as many of the small varieties on a given area, as of the largest growers. Distances apart will also be determined in part by the character of the soil. A very rich soil will support more plants than a poor soil. When the nature and habits of the varieties are determined and when the character of the soil is considered, then the question of distances will be determined, and the method of planting will logically follow. Our preference is toward the check, or square system, if the land is suited to that style of planting. Our reasons are that, by that method, more fruit and better fruit can be produced with a given amount of labor than by any other. By this method the land can be cultivated both ways and the work of hoeing largely eliminated. By this method also the sun shines more evenly upon all parts of the plant and tends toward a fuller and more uniform development of the fruit.

If the row method is adopted, run a deep furrow where the plants are to be placed. If the square or check method is adopted, mark off the land both ways and run a deep furrow one way. Then prune the broken roots and cut back the top to about four to eight inches in height; they are then ready for setting. In setting the plants, care should be used to prevent the drying of the roots. Perhaps the best method is to place the roots in water, having one man to drop them and two to set them. The three working together make a team. This will set the plants with less labor than a smaller number working a longer period of time. Some recommend that the "dropper" carry the plants in a bucket of water. This will do if only a small number are to be set, but if a large field is to be planted it is easier to have a broad water-tight box on a sled, in which the plants are placed, and drawn by a horse. For the number of plants per acre, see our "Table of Distances," page 155. Set the plants from a half to one inch deeper than they grow in the nursery.

Cultivation

The cultivation blackberries should receive depends mostly on the conditions under which they grow. If they grow where there is a lack of moisture, it will be necessary to keep the ground thoroughly pulverized, so as to form a dust mulch and conserve the moisture. Sometimes it will be necessary also to mulch with straw, barnyard manure or leaves.

In portions of the country where irrigation is practiced and where there is plenty of moisture, the land should be cultivated after each and every irrigation, which would probably be about every 20 to 30 days. In any event, the weeds and the suckers must be kept down and the land kept well pulverized, so that by the process of aeration, the roots are properly supplied with food.

Training and Staking

Upon this subject we quote here from W. S. Thornber, formerly professor of horticulture at Pullman, Wash.

"The 'Upright Growers' where planted in hills can best be staked by a single strong stake from four to six feet in height and the canes loosely but securely fastened to the stake. Some growers prefer to set two stakes about 15 inches apart at each hill of blackberries with the idea of training the fruiting canes on one and the growing canes on the other. Where the 'Upright Growers' are planted in a continuous row they may be trained to and supported by a two-wire trellis consisting of a single row of posts four to five feet high with a single No. 10 wire stapled to the top and another from 18 to 24 inches from the top. The more common method however, is to set a single line of posts four or five feet high in the row, nail an 18-inch cross-arm three feet from the ground and another at the top of the posts, and to the ends of these arms staple heavy wires, thus forming firm lateral supports for the canes.

"The four-wire trellis with the addition of notched cross pieces to lay on the lower wires makes an excellent support for the 'Viny Growers,' the purpose being to suspend the growing canes by means of small cloth strings under the upper wires for the first year and at pruning time lower them to rest on the notched pieces on the lower wires for their fruiting period. This makes an easy system to work and keeps the growing and fruiting canes separate, thereby simplifying the picking."

Pruning

The pruning of the blackberry is a simple matter, if only a few rules are observed.

The first is to keep the tops cut back, or pinched back to the proper height, during the growing season while they are young and tender. This allows the plant to grow stocky, and to mature better fruit than if the strength of the plant had been allowed to produce more wood growth. The second is to remove the old canes in winter or spring.

Some varieties of plants will grow on good soils from 10 to 20 feet in height. This makes the picking of the fruit impossible. These should be cut back during the growing season. Others tend to grow shaggy and bushy. In such a case it might be found advisable to train them to grow taller.

In very cold climates the pruning should be done in the autumn, the plants laid down and given a covering of straw or earth to prevent freezing, but where this is done, berries are grown mostly for home use, as it does not pay to grow fruits for the general markets in competition with those sections where the conditions are more favorable and the fruit can be produced with less labor.

Picking and Marketing

For long shipments the berries should be picked as soon as colored. However, it must be borne in mind that blackberries color before they are ripe enough to have a pleasant taste. It is regrettable that so many varieties of fruits, in order to reach the markets in good condition, must be picked before they are ripe, but in many cases this is true. However, by the use of refrigerator cars, pre-cooling methods and rapid transit, the fruit may be left to ripen, unless intended for long distance shipment.

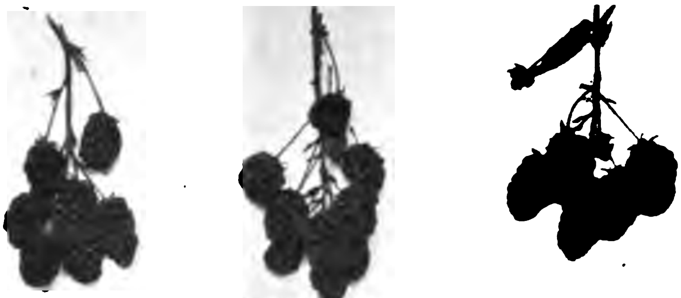
After picking, the berries should not be allowed to stand in the sun because, if thus exposed, they develop a bitter taste.

Perhaps the most convenient package for blackberries, strawberries or any kind of small fruit, is the strawberry box. It is a size to which the public is accustomed and which manufacturers are prepared for making without readjusting their machinery.

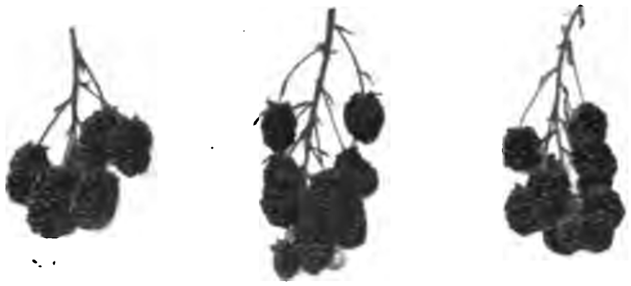
Drying Blackberries

The drying of blackberries has been strongly recommended by a great many persons. The experience of some persons leads to the conclusion that it pays, while others are of a contrary opinion. Card, in his "Bush Fruits," gives it as his opinion that it does not pay. His reasons are, that the blackberry by evaporation loses much of its flavor. Then, too, it comes into competition with the fresh berries, grown in the South and shipped into Northern markets. These berries from the South are not considered equal in flavor to the berries grown in the North, yet they are so far superior to the Northern berry dried that they practically destroy the demand for the dried product. In our experience, the competition with the canned product is formidable, and we should not, therefore, attempt to dry blackberries for the general market unless under conditions where canning was impracticable. However, there are markets for dried fruits. We may take as an illustration, Alaska, where the costs of shipment are high, and where all fruits are scarce.

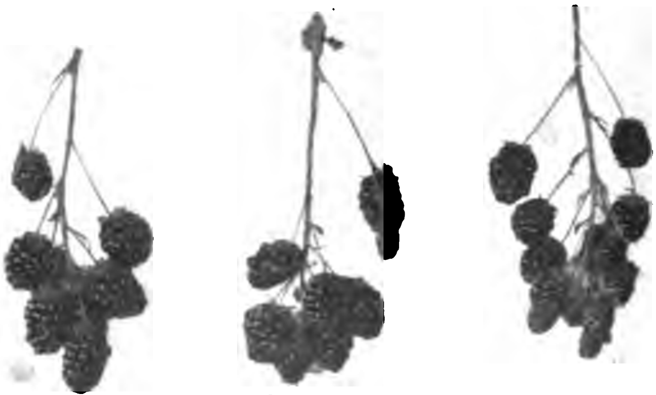
The profits in berries are all the way from $100 per acre to $500 net, depending on the man, the varieties, and the circumstances under which grown and marketed.



Mercereau Early Harvest Texas



Minnewaski Snyder Stones Hardy



Kittatinny Parker Ohmer

Blackberries

1—**Mercereau**: Fruit large, rather acid, of good quality, quite soft; season long, a good berry for home use. 2.—**Stone's Hardy**: Fruit medium in size, quite prolific and of fair quality. 3—**Texas**: Fruit of good size, very prolific, rather soft when fully ripe; earlier than the Snyder but of poorer quality. 4—**Minnewaski**: Fruit medium in size, and of fair quality; not as good as Snyder. 5—**Snyder**: The most popular blackberry; fruit medium in size, very firm, prolific and of excellent quality; very subject to disease. 6—**Early Harvest**: Fruit early, small, acid, not profitable here. 7—**Kittatinny**: Fruit rather large, quite firm, of fair quality, not as prolific as the Snyder, not as good a berry. 8—**Parker**: A berry of good size, quality, and firmness, grown locally in Whatcom county where it is said to equal or excel the Snyder. 9—**Ohmer**: A berry of medium size, fair quality and not very prolific. 10—**Mammoth** (not on the photo): Fruit large, acid, good quality. Plant has a trailing habit and very thorny. Not prolific enough to be grown with profit.

Photo and Descriptions by J. H. Stahl, Western Washington Experiment Station

Varieties Recommended for Planting Washington

W. S. Thornber, formerly Horticulturist Washington State College, recommends the following for that state:

Early Mammoth—An early fine large, rich flavored berry. Rather tender for general planting but valuable where quality is desired.

Evergreen—One of our hardiest, most productive and best all-round late blackberries. Value for commercial as well as home growing purposes.

Himilaya Giant—A rather slight known, productive, rank-growing, viny sort. Valuable for commercial planting west of the Cascade mountains, but too tender for general planting.

Kittatinny—A very commonly planted sort, and while rather tender and subject to rust, yet produces very satisfactory crops.

Snyder—One of our best and most popular early sorts. Valuable for commercial as well as home purposes.

Stones' Hardy—An old, well-known, late variety. Valuable only where the more productive sorts will not stand the winters.

Loganberry—One of our newer fruits which is rapidly becoming popular on account of its productiveness, large fruit and fine quality. Grows well in all parts of the state but requires light winter protection in eastern Washington.

Phenomenal Berry—A fruit closely resembling the loganberry and profitably grown under the same conditions.

Lucretia Dewberry—A valuable but not well known recent addition to the blackberry family. While it is hardy, its trailing habit makes it possible to successfully grow this plant, by giving it winter protection, where the ordinary blackberry winter kills. Its early fruiting habit, productiveness and ability to thrive on many soils makes it popular as an orchard filler in many parts of the state.

GRANVILLE LOWTHER

Cost of Growing Blackberries in the Puyallup Valley

It is estimated in the Puyallup valley that it costs the grower 25 cents per crate of 24 crates for picking. The crate costs 15 cents; hauling to the depot and other incidentals, 7½ cents; cultivation and taking care of the canes, 7½ cents. Add to this the Association charge, which will average about 5 cents per crate, and there is a total of 60 cents. President W. H. Paulhamus states that the P. & S. Association can sell the Evergreen blackberries at an average net return to the grower of 85 cents, and he still has 25 cents per crate above the cost of production. Eight hundred crates to the acre would mean $200 per acre profit. Six hundred crates per acre means $150 per acre profit, providing the market is ample.—*Northwest Horticulturist.*

Blackberries Recommended

Blackberries recommended for cultivation, in the various districts, by the American Pomological Society.

For map of districts see recommendations under apple, page 192.

District No. 1

RECOMMENDED—*Dessert, kitchen and market*: Eldorado. *Dessert and market:* Agawam; Minnewaska; Snyder. *Dessert and kitchen*: Lucretia (dewberry). *Market*: Briton, *Ancient;* Erie. *Dessert*: Stone; Taylor; Triumph, *Western;* Wachusett.

District No. 2

HIGHLY RECOMMENDED — *Dessert and market*: Agawam; Early Harvest; Snyder. *Dessert and kitchen*: Lucretia (dewberry). *Market*: Briton, *Ancient;* Erie; Wilson. *Dessert*: Taylor.

RECOMMENDED—*Dessert, kitchen and market*: Eldorado. *Dessert and market*: Brunton; Minnewaska. *Market*: Lawton. *Dessert*: Kittatinny; Stone; Triumph, *Western;* Wachusett.

RECOMMENDED FOR TRIAL—*Dessert and market*: Allen.

District No. 3

HIGHLY RECOMMENDED—*Dessert and market*: Early Harvest; Minnewaska. *Dessert and kitchen*: Lucretia (dewberry). *Market*: Erie.

RECOMMENDED—*Dessert, kitchen and market*: Eldorado. *Dessert and market*: Mayes (*Austin*) [dewberry]; Snyder.

Market: Briton, *Ancient;* Wilson. *Dessert*: Kittatinny; Taylor.

District No. 4

HIGHLY RECOMMENDED—*Dessert and market:* Mayes (*Austin*) [dewberry]; Snyder. *Dessert and kitchen*: Lucretia [dewberry]: *Market*: Lawton. *Dessert*: Kittatinny.

RECOMMENDED—*Dessert and market*: Early Harvest; Minnewaska. *Market*: Briton, *Ancient;* Erie. *Dessert:* Taylor; Wachusett.

RECOMMENDED FOR TRIAL — *Dessert:* Triumph, Western.

District No. 5

HIGHLY RECOMMENDED—*Dessert, kitchen and market*: Dallas. *Dessert and market*: Early Harvest; Snyder. *Dessert and kitchen*: Lucretia [dewberry]. *Market*: Erie. *Dessert*: Kittatinny; Stone.

RECOMMENDED—*Dessert and market*: Mayes *(Austin)* [dewberry]; Minnewaska. *Market*: Lawton, Wilson.

District No. 6

HIGHLY RECOMMENDED—*Dessert and market*: Mayes (*Austin*) [dewberry]. *Dessert and kitchen*: Lucretia [dewberry].

RECOMMENDED—*Dessert, kitchen and market*: Dallas. *Dessert and market*: Brunton. *Dessert*: Kittatinny. *Market*: Briton, *Ancient.*

District No. 7

HIGHLY RECOMMENDED—*Dessert, kitchen and market:* Dallas. *Dessert and market:* Brunton; Early Harvest; Mayes (*Austin*) [dewberry]. *Dessert and kitchen:* Lucretia [dewberry]. *Dessert:* Kittatinny.

RECOMMENDED — *Dessert, kitchen and market:* Eldorado. *Kitchen and market:* Robison. *Dessert and market:* Minnewaska. *Market:* Briton, *Ancient. Dessert:* Taylor.

District No. 8

HIGHLY RECOMMENDED—*Dessert and market*: Early Harvest; Mayes *(Austin)* [dewberry]; Snyder. *Dessert and kitchen*: Lucretia [dewberry]. *Market*: Briton, *Ancient;* Erie. *Dessert*: Taylor.

RECOMMENDED—*Market*: Lawton. *Dessert*: Wachusett.

RECOMMENDED FOR TRIAL—*Dessert, kitchen and market*: Eldorado.

District No. 9

HIGHLY RECOMMENDED—*Market*: Briton, *Ancient.*

RECOMMENDED—*Dessert and kitchen:* Lucretia [dewberry].

Districts No. 10 and No. 11

HIGHLY RECOMMENDED—*Market*: Briton, *Ancient;* Wilson; Robison.

RECOMMENDED—*Dessert and market*: Agawam; Early Harvest; Minnewaska; Snyder. *Dessert and kitchen*: Lucretia [dewberry]; Dallas. *Market*: Erie; Lawton. *Dessert*: Kittatinny; Taylor.

District No. 12

HIGHLY RECOMMENDED — *Dessert and market*: Snyder. *Dessert and kitchen:* Lucretia (dewberry). *Market*: Briton, (*Ancient*), Wilson. *Dessert*: Taylor.

RECOMMENDED — *Dessert and market*: Early Harvest. *Market*: Erie; Lawton. *Dessert*: Kittatinny; Stone.

District No. 13

HIGHLY RECOMMENDED — *Dessert and kitchen*: Lucretia (dewberry).

RECOMMENDED — *Dessert and market*: Snyder. *Market*: Wilson.

District No. 14

HIGHLY RECOMMENDED — *Dessert and kitchen*: Lucretia (dewberry), *Market*: Erie; Lawton. *Dessert*: Kittatinny.

RECOMMENDED — *Dessert and market*: Snyder. *Market:* Briton, *Ancient;* Wilson.

RECOMMENDED FOR TRIAL—*Dessert, kitchen and market*: Eldorado. *Dessert and market*: Early Harvest.

District No. 15

HIGHLY RECOMMENDED — *Market:* Lawton. *Dessert*: Kittatinny.

RECOMMENDED — *Dessert and market*: Snyder. *Dessert*: Stone.

District No. 16

RECOMMENDED—*Market*: Lawton. *Dessert*: Kittatinny; Crandall.

District No. 17

RECOMMENDED — *Dessert and market*: Early Harvest. *Market*: Lawton; Wilson. *Dessert*: Kittatinny; Crandall.

District No. 18

HIGHLY RECOMMENDED—Crandall.

RECOMMENDED — *Dessert and kitchen:* Lucretia (dewberry). *Market*: Lawton. *Dessert*: Kittatinny.

BLACKBERRY DISEASES

ANTHRACNOSE. See *Raspberry*.

BRAMBLE RUST. See *Rust*, this section.

Crown Gall

Bacterium tumefaciens

Produces large swellings just below the ground. Destroy all affected plants and use care in planting clean stock.

For extended article on crown gall, see under *Apple*.

Fruit Rot

Botrytis

The ripe fruit decays on the bushes and is covered with a gray, dusty mould. More abundant in moist weather.

No treatment feasible. Affected fruits should be discarded, as the rot will spread to unaffected fruit after picking.

Leaf Spot

Septoria rubi

Produces small dead spots on the leaves. Spray with Bordeaux mixture about four times at intervals of about ten days, the first application when the buds are beginning to unfold.

R. E. SMITH,
Berkeley, Cal.

MUSHROOM ROOT ROT. See *Raspberry*.

ORANGE RUST. See *Rust*, this section.

Red or Bramble Rust

Caeoma nitens Schw.

Wild and cultivated blackberries suffer from this disease as well as raspberries.

Similar in appearance to the orange rust and requires the same treatment.

Rust, Orange Rust

Gymnoconia interstitialis

Produces bright orange masses of spores all over the under side of the leaves. The fungus spreads all through the plant so that it is not easily controlled.

Cut affected plants to the ground and burn. Spray new growth with Bordeaux mixture.

R. E. SMITH,
Berkeley, Cal.

BLACKBERRY PESTS

AMERICAN RASPBERRY BEETLE. See *Raspberry*.

APPLE LEAF HOPPER. See under *Apple*.

BLACK CHERRY APHIS. See *Aphids*.

BLACKBERRY APHIS. See *Aphids*.

The Blackberry Crown Borer

Bembecia marginata

This borer does considerable damage. After growth starts in the spring, some canes may be found to be dead. In some cases, an examination will reveal at the base of such canes, a 16-legged borer, resembling the peach borer. Many of such canes will be found to have been partially girdled just at the base during the preceding fall, and the pith of the same bored out by the caterpillar. The parent moth is a clear winged insect, quite resembling a brightly colored wasp. The body is black, banded and marked with yellow. The eggs are laid in the fall. The most reliable remedy is to cut out all infested canes as soon as they are discovered and burn, taking care not to allow any of the borers to escape from the canes before they are burned.

H. A. GOSSARD,
Wooster, Ohio.

BLACK PEACH APHIS. See *Aphids*.

Bramble, Flea Louse

Trioza tripunctata Fitch.

A tiny insect which has been found to be troublesome in some of the Eastern states. A curling of the leaves follows the attack. The nymphs are covered with jointed waxy threads which break off readily and give the leaf a powdery appearance when the insects are numerous.

As soon as the winged forms appear spray with kerosene emulsion.

Not likely to become serious.

BUD MOTH. See under *Apple*.

Cane Borer of Blackberry and Raspberry

Oberea bimaculata

The adult beetle girdles the tip of the cane with a row of punctures in laying her eggs, so that the tips droop and wither. The grub is a blind worm without feet and burrows downward in the pith. It has a brown head and by fall is about an inch long.

Affected canes should be cut out and burned, if in midsummer, below the girdled tip; if in the autumn, at the ground.

FLEA LOUSE. See *Bramble-Flea Louse*, this section.

Gouty-Gall Beetle

Agrilus ruficollis

The young borers of this species commence work in July and August. The slender, round-headed larvae enter the canes at the bases of the leaf stalks, and from such points work around the canes in long, spiral tunnels through the sapwood. Later in the season, the canes swell over the eaten areas, forming enlargements or galls which are very conspicuous when the leaves fall. The only remedy is to prune out and burn the galls containing the larvae, and since galled canes will never prove of value, they may be cut out whenever discovered. Cut wild canes along roadsides and in nearby woodlands and burn in the fall of the year after the larvae have entered them.

H. A. GOSSARD,
Wooster, Ohio.

LEAF HOPPER. See under *Apple*.

OYSTER SHELL SCALE. See under *Apple*.

PALE BROWN BYTHURUS. See *Raspberry*.

Pithy Gall and Seed-like Gall

A large gall, two or three inches long, sometimes found on blackberry canes, is divided by four or five furrows into as many longitudinal lobes. Within the gall can be found small, footless, whitish grubs, which, in the spring of the year, transform to small, four-winged flies. The insect is not very important, but the galls should be pruned out and burned. This formation is known as the pithy gall of the blackberry, and the insect causing it is *Diastrophus nebulosus*.

A closely related gall of the blackberry is known as the seed-like gall, and is caused by *Diastrophus cuscutaeformis*, much resembling the preceding species. This is a composite gall, consisting of a ring of single seed-like galls, the belt being an inch or an inch and one-half in depth. Cut out and burn.

H. A. GOSSARD,
Wooster, Ohio.

RASPBERRY BEETLE. See under *Raspberry*.

RASPBERRY HORN TAIL. See *Raspberry*.

RED SPIDER. See under *Apple*.

The Rose Scale

Aulacaspis rosae Bouche

General Appearance

The female scales are nearly circular with very irregular edges and white to gray in color with reddish body. The diameter varies from one-sixteenth to one-eighth of an inch. The male scales are long and narrow, very minute, with three longitudinal creases, or carinæ, and the bodies reddish white.

Life History

All stages of this scale occur practically throughout the entire year, including the eggs, and its spread is very rapid. The females cluster in great numbers on the canes of berries and roses, especially around the crown of the roots. It is especially abundant during the spring and summer months. It attacks wild and cultivated plants.

Food Plants

Blackberries, raspberries and roses. Abundant on wild blackberries in the Sacramento valley.

Control

As the eggs are present at practically all seasons and are hard to kill, by either spraying or fumigation, this is a somewhat difficult scale to control. The worst infected canes should be cut out and burned and the remaining sprayed successively with kerosene, distillate or carbolic acid emulsion, or with lime-sulphur when the plants are dormant in the winter.

E. O. ESSIG

SAN JOSE SCALE. See under *Apple*.

Saw Fly

Pamphilius dentatus

A small green worm the larva of one of the sawflies, feeds on the under side of the leaves.

Spray with Paris green, arsenate of lead or, if the fruit has formed, with hellebore.

For formulae see *Sprays.*

SCURFY SCALE. See under *Apple.*

SEED-LIKE GALL. See *Pithy Gall*, this section.

Snowy Tree Cricket

Oecanthus niveus DeGeer

General Appearance

The adult insects are slightly more than half an inch long and light yellow or greenish in color. The antennæ are very long and hair-like. There is one black dot on the face beneath each antenna. The females appear narrow, because the wings are folded along the sides and over the backs, while in the males they are spread out flatly on the back. The black-tipped ovipositor also helps to distinguish the female. The eggs are about one-eighth of an inch long, slender, slightly curved and white. They are inserted in the stems of the host.

Life History

The eggs are placed singly in the canes or twigs in the autumn and remain dormant during the winter. The first warm spring days cause them to hatch and the young, wingless, green crickets begin feeding upon plant lice or other soft-bodied insects. Throughout its entire life, from the time it leaves the egg until egg-laying commences in the fall the insect is working for the benefit of the farmer. By autumn all forms are mature and egg-laying begins, the adults disappearing soon afterwards.

Food and Host Plants

The damage done by the snowy tree-cricket is due almost entirely to its method of puncturing the small stems and canes in egg-laying. It often happens that so many eggs are placed in the canes as to cause considerable loss. Raspberries and blackberries receive the most injury, though young deciduous fruit nursery stock is also often severely injured.

The feeding habits of this species places it among the beneficial insects and partially offset the damage done in depositing the eggs. The young and old alike feed upon soft-bodied insects, principally plant lice, and due to their ravenous appetites they are able to consume great numbers of other injurious pests.

Control

The method of eliminating subsequent broods and attacks consists in cutting out all canes showing the characteristic signs of having been punctured for egg-laying. It has been said by many reliable authorities that the good done by the snowy tree cricket in destroying injurious plant lice and other soft-bodied insects more than recompenses the farmer for the harm done and that only in rare cases should the eggs be destroyed, even after the injured canes or branches have been removed.

E. O. ESSIG,
Sacramento, Cal.

TARNISHED PLANT BUG. See *Strawberry.*

TREE CRICKET. See *Snowy Tree Cricket*, this section.

Blooming Period of Tree Fruits

The value of bloom charts and their bearing on the question of mixed planting is appreciated by a large number of our best fruit growers, but a brief discussion of the subject may be of value.

Causes of Unfruitfulness

Probably the most frequent questions asked by orchardists relate to the barrenness of orchards and the causes of unfruitfulness.

There are many conditions which prevent a normal development of bloom and set of fruit. The following may be enumerated:

Rapid Wood Growth

It has been often observed that trees making very rapid wood growth fail to bear heavy crops of fruit. This is well illustrated in the case of young trees which fail to bear during the first years of their growth. The reason for this is not well understood, but it is fully established that the growth and reproductive forces are in a measure alternative and that whatever favors the one will retard the other. While over-rapid growth always tends to lessen the fruitfulness of a tree, lack of food or insufficient nourishment will produce the same effect. The remedy in either case is obvious and the condition is readily corrected.

Diseases Attacking Bloom and Unfavorable Weather Conditions

One of the most frequent causes of failure to set fruit is due to the attack of bloom by fungi. The brown rot of stone fruits and the scab of apple is often responsible for failures which the grower attributes to frost or winter freezing. These diseases not only attack and kill the crop of bloom but they may so injure the tree as to prevent the formation of a crop of bloom for the following year. It is probable that many diseases act in an indirect way to prevent fruitfulness. In addition to actual parasitic diseases, unfavorable weather may result in pathological conditions which prevent a set of fruit; or, on the other hand, they may simply prevent pollination, which has the same result. More than once we have noted a failure in crop due entirely to continued rainfall during the blooming season.

The effect of winter freezing and frost is largely beyond the control of the grower and need not be discussed here. Other minor causes of unfruitfulness might be enumerated, but it is our purpose to discuss only the chief causes in such manner as will illustrate the use and value of the bloom charts published below. Probably the chief and most frequent cause of unfruitfulness in orchards is due to self-sterility and the lack of pollenizers for the self-sterile varieties.

Self-Sterility and Mixed Planting

Self-sterility may be defined as the inability of certain varieties to set fruit when offered only their own pollen. Other minor causes such as imperfect pistils and insufficient supply of pollen may be responsible for sterility in flowers, but such defects are not usually numerous enough to affect the crop materially. Self-sterility is due to the impotency of the pollen of certain varieties toward its sisterhood of pistils. This pollen may be quite virile on other flowers but has no affinity for its own. Waite was the first investigator in this country to give this subject close study, and his work has fully demonstrated the fact that many varieties of both pear and apple are either partially or wholly unfruitful when planted in large blocks to themselves. Waite also found that even where self-sterility did not prevail that cross pollination among varieties resulted in better development of fruit. Waugh has made exhaustive studies on this subject so far as it relates to plums and his conclusions are that practically all varieties of native plums and many of the Japanese group are unable to set fruit without the pollen of a second variety. Fletcher has added the further knowledge that self-sterility and self-fertility are not constant varietal characters, but depend to some extent on climatal or other environmental conditions. The subsequent studies of many investigators and the general experience of orchard practice confirm these conclusions; and the majority of well informed fruit growers now consider mixed planting a necessity. The practical question at once arises: What variety shall be selected as pollenizer for any given sort.

Selection of Pollenizer

Two factors must be taken into consideration in the selection of varieties for cross-pollination. First, there must exist a mutual affinity between the two; and secondly, they must bloom at practically the same time.

The subject of mutual affinity is a very important and interesting one, and has a direct bearing on the whole problem. But, thus far, little is known regarding such affinities, and the way to further knowledge is beset by so many obstacles that few investigators have the courage to undertake exhaustive research along this line. We have some knowledge of the subject so far as it relates to different groups of the same fruit, but this knowledge should be extended to the relation between varieties of the same group if we are to be in a position to give a definite answer to the question suggested above. It is common knowledge that European or Domestica plums cross with difficulty on other types of this fruit, and that this group should, therefore, be considered separately and apart from other plums when selecting cross pollenizers. On the other hand, all groups of native plums together with the Japanese varieties interpollinate rather freely, and thus we may be quite indifferent as to group relations when considering varieties falling under these heads. However, we are not prepared to say whether or not there is any difference in the degree of affinity between varieties of the same group, or if such affinity does exist whether it is a constant character or not. Until we are able to answer definitely these questions, the bloom chart is the only safe guide we have in selecting varieties for the purpose of cross-pollination. Waugh has probably given this problem more attention than any other student, and his work has led him to lay very little stress on mutual affinity in his latest publications on this subject. In a number of preliminary hand cross-pollinations with apples at this station, the results indicate that the female parent to the cross is quite indifferent to the kind of pollen offered so long as it is of another variety of apple and is in good condition; but our trials have not been sufficiently extensive to draw positive conclusions.

If these conclusions are correct, then the bloom chart is even more valuable than at first supposed; but in any case it must always be consulted if we are to practice mixed planting with success. Planting together varieties of different blooming periods does not meet the needs in the case, but the kinds that have practically the same blooming period should be selected. Although a number of experiment stations have published blooming data for the benefit of the grower, yet none of these apply to the Virginia planter. It is a well known fact that the relative blooming period of a series of varieties will not be the same for different localities, especially if they be remote from each other. No one chart can be constructed that will apply with equal force to all sections of the United States. However, charts that apply to other sections have some value and should be consulted in the event that there is lack of more definite information. Though Virginia has a rather variable climate, the territory covered is not so extensive, but that data taken in one locality will apply in a fair degree to the rest of the state.

The chart on pp. 656-7-8-9 is therefore expected to serve as a safe guide to the Virginia fruit grower. It has been compiled from a large mass of notes extending over a period of 13 years; the number of observations, each representing a different year, is given in the left-hand column just after the variety name. The number of years covered guarantees a safe norm, whereas norms reached by only three or four observations would hardly appear to be reliable. The apple orchard was planted in the spring of 1889, but all notes on apple collected prior to 1896 have been disregarded because of the unreliability of bloom notes from trees during their earlier stages of growth.

The next step in this work should be the collection of blooming data from different sections of the state with the view of developing a phenological map for Virginia, and to this end we solicit the cooperation of all those who are interested in this subject. Bloom note forms and instructions will be furnished those desiring to aid us in these studies.

Explanation of Chart

In the charts following the blooming period of each given variety is represented by the starred line following the name. This line begins with the average recorded for first bloom open and extends two days beyond the period of full bloom. While flowers remain receptive for more than two days after full bloom during cloudy weather, this is not the case if conditions are favorable to pollination. The different fruits or groups of same are arranged in order of their blooming, as this arrangement appears best for comparisons.

For APPLES, see *Pollination*, under *Apple*.

Normal Bloom Chart

PLUMS	No. of Observations	APRIL																							MAY			
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4
I. DOMESTICA GROUP (*Prunus Domestica*)																												
Grand Duke	9								●	●	●	●	●	●	●													
Imperial	9										●	●	●	●	●	●	●											
Yellow Egg	12										●	●	●	●	●	●	●	●										
McLaughlin	10											●	●	●	●	●	●	●	●									
Agen (*Prunede*)	10											●	●	●	●	●	●											
Bavay	10											●	●	●	●	●	●	●										
Golden Drop (*Col.*)	7											●	●	●	●	●	●	●										
Geuli	7											●	●	●	●	●	●	●										
Reine Claude	11											●	●	●	●	●	●	●										
Quackenbos	6											●	●	●	●	●	●	●	●									
Lombard	10												●	●	●	●	●	●										
Bradshaw	8												●	●	●	●	●	●	●									
Bunker Hill	8												●	●	●	●	●	●	●									
Fellenberg	7												●	●	●	●	●	●	●									
Italian	6												●	●	●	●	●	●	●	●								
Shropshire	12												●	●	●	●	●	●	●									
White Damson	2												●	●	●	●	●	●	●									
German	10														●	●	●	●	●	●								
Pond	10														●	●	●	●	●	●								
Naples	7															●	●	●	●	●	●	●	●					
Washington	5																●	●	●	●	●							
Englebert	5																●	●	●	●	●	●	●					
II. JAPANESE GROUP (*Prunus triflora*)																												
Abundance	11	●	●	●	●	●	●	●	●	●	●																	
Clyman	1		●	●	●	●	●	●	●	●	●	●	●															
Red June	4			●	●	●	●	●	●	●	●			Syns.														
Red Nagate	5			●	●	●	●	●	●	●	●																	
Wickson	5			●	●	●	●	●	●	●	●																	
Berckmans	5				●	●	●	●	●	●	●	●	●	●														
Burbank	5				●	●	●	●	●	●	●	●	●	●														
Georgeson	5				●	●	●	●	●	●	●	●	●															
Mikado	5				●	●	●	●	●	●	●	●	●															
Maru	5					●	●	●	●	●	●	●	●															
Kerr	5					●	●	●	●	●	●	●	●															
Normand	4							●	●	●	●	●	●	●	●	●	●	●										
White Kelsey	5				●	●	●	●	●	●	●	●	●															
Hale	4									●	●	●	●	●	●	●	●	●										
Juicy	5											●	●	●	●	●	●	●	●									
Kelsey	6												●	●	●	●	●	●	●	●	●							
Chabot	4												●	●	●	●	●	●	●	●								
Yosebe																												

Normal Bloom Chart

PLUMS	No. of Observations	APRIL																							MAY			
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4
III. SIMON GROUP (*Prunus Simonii*)																												
Simon	9										●	●	●	●	●	●												
IV. MARIANA GROUP (*Prunus cerasifera*)																												
Brill	5								●	●	●	●	●	●	●	●	●											
Tarleton	5					●	●	●	●	●	●	●	●	●	●													
Mariana	12								●	●	●	●	●	●	●	●												
V. CHICKASAW GROUP (*Prunus angustifolia*)																												
Robinson	12										●	●	●	●	●	●	●	●										
Beaty	5													●	●	●	●	●	●	●	●							
Newman	4													●	●	●	●	●	●	●	●							
Cluck	5															●	●	●	●	●	●	●	●	●				
Munson	5															●	●	●	●	●	●	●	●					
Lone Star	5															●	●	●	●	●	●	●						
VI. HORTULANA GROUP (*Prunus hortulana*)																												
Wild Goose	11											●	●	●	●	●	●	●										
Whitaker	4												●	●	●	●	●	●	●	●								
Clifford	4													●	●	●	●	●	●	●	●	●						
Wooten	8														●	●	●	●	●	●								
Choptank	5															●	●	●	●	●	●	●						
Milton	5															●	●	●	●	●	●	●						
Sophie	5															●	●	●	●	●	●	●						
Roulette	5															●	●	●	●	●	●	●	●					
Smiley	5															●	●	●	●	●	●	●	●					
Kroh	5															●	●	●	●	●	●	●	●					
Downing	5																●	●	●	●	●	●	●					
Dunlap	5																●	●	●	●	●	●	●					
Vick	3																			●	●	●	●	●	●	●	●	
VII. WAYLAND GROUP (*Prunus hortulana*)																												
Captain	5													●	●	●	●	●	●	●	●	●						
Wayland	6															●	●	●	●	●	●							
Benson	5															●	●	●	●	●	●	●	●					
Reed	5															●	●	●	●	●	●	●	●	●	●			
Moreman	5																●	●	●	●	●	●	●	●	●			
Kanawha	5																		●	●	●	●	●	●	●	●		

Normal Bloom Chart

PLUMS	No. of Observations	APRIL																							MAY			
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4
VIII. Miner Group (*Prunus hortulana*)																												
Prairie Flower	5														●	●	●	●	●	●	●	●						
Wilder	5														●	●	●	●	●	●	●	●	●					
Nebraska	5															●	●	●	●	●	●	●						
Idall	5															●	●	●	●	●	●	●	●					
Wier No. 50	5																●	●	●	●	●	●	●	●	●			
Miner	5																	●	●	●	●	●	●	●	●	●		
IX. Americana Group (*Prunus Americana*)																												
Dahlgreen	5										●	●	●	●	●	●	●	●	●									
Marcus	5											●	●	●	●	●	●	●	●	●								
Wolf	3												●	●	●	●	●	●	●									
American Eagle	3												●	●	●	●	●	●	●	●								
Keith	5												●	●	●	●	●	●	●	●								
Pur. Yosemite	5													●	●	●	●	●	●	●								
Marion	5													●	●	●	●	●	●	●	●							
Bixby	3													●	●	●	●	●	●	●	●	●	●					
Dunlap No. 1	5													●	●	●	●	●	●	●	●	●	●					
Forest Garden	5															●	●	●	●	●	●	●	●					
Stoddard	5															●	●	●	●	●	●	●	●	●				
Hawkeye	5																●	●	●	●	●	●	●	●				
X. Nigra Group (*Prunus Americana nigra*)																												
Cheney	2				●	●	●	●	●	●	●	●																
Smith Red	5																			●	●	●	●	●	●	●	●	●
XI. Misc. Varieties																												
Red Panhandle	2											●	●	●	●	●	●											
Heldman Black	5																●	●	●	●	●	●	●	●	●	●		
Compass	4																	●	●	●	●	●	●	●	●	●	●	●

Normal Bloom Chart

PEARS	No. of Observations	APRIL															MAY					
		16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6
Dewey's Prem	2	●	●	●	●	●	●															
Kieffer	13		●	●	●	●	●	●	●	●												
Leconte	9		●	●	●	●	●	●	●	●	●											
Lawson	10				●	●	●	●	●	●	●	●										
Anjou	12					●	●	●	●	●	●	●										
Lawrence	12					●	●	●	●	●	●	●										
Maury	3					●	●	●	●	●	●	●										
Marguerite	12					●	●	●	●	●	●	●	●									
Rutter	10					●	●	●	●	●	●											
Clairgeau	13						●	●	●	●	●	●										
Clapp	9						●	●	●	●	●	●	●									
Easter Beurre	9						●	●	●	●	●	●										
Howell	12						●	●	●	●	●	●										
Osband	12						●	●	●	●	●	●	●									
Sum. Doyenne	9						●	●	●	●	●	●										
White Doyenne	10						●	●	●	●	●	●										
Bartlett	12							●	●	●	●	●	●									
Bosc	11							●	●	●	●	●	●	●	●							
Boussock	10							●	●	●	●	●	●	●	●							
Early Wilder	8							●	●	●	●	●	●	●								
Malines	11							●	●	●	●	●	●									
Louise	11							●	●	●	●	●	●									
Pound	10							●	●	●	●	●	●	●								
Seckel	9							●	●	●	●	●	●	●								
Sheldon	10							●	●	●	●	●	●	●	●							
Superfine	10							●	●	●	●	●	●									
Lucrative	12								●	●	●	●	●	●	●							
Buffum	9								●	●	●	●	●	●								
Duchess Precose	10								●	●	●	●	●									
Flemish Beauty	7								●	●	●	●	●	●	●							
Idaho	5								●	●	●	●	●	●	●	●	●					
Elizabeth	8								●	●	●	●	●	●								
Tyson	9								●	●	●	●	●									
Vicar	8									●	●	●	●	●	●							
Souvenir	8										●	●	●	●	●	●						
Bessemiankee	1															●	●	●	●	●	●	●

Normal Bloom Chart

CHERRIES	No. of Observations	APRIL															
		15	16	17	18	19	20	21	22	23	24	25	26	27	28	39	30
Ey. LaMaurie	8	●	●	●	●	●	●	●									
Mezel	11	●	●	●	●	●	●	●	●	●	●						
Windsor	13		●	●	●	●	●	●	●	●	●						
Ey. Purple	12			●	●	●	●	●	●	●							
Sparhawk	11			●	●	●	●	●	●	●	●						
Coe	13				●	●	●	●	●	●	●						
Gov. Wood	11				●	●	●	●	●	●	●						
Rockport	13				●	●	●	●	●	●	●						
Tartarian	13				●	●	●	●	●	●	●						
Tradescant	11				●	●	●	●	●	●	●	●					
Elton	10					●	●	●	●	●	●	●	●				
Hortense	12					●	●	●	●	●	●	●					
Ostheime	11					●	●	●	●	●	●	●					
Olivet	11					●	●	●	●	●	●	●	●	●			
Napoleon	10						●	●	●	●	●	●	●				
Schmidt	12						●	●	●	●	●	●	●				
Philippe	12						●	●	●	●	●	●	●	●	●	●	
Kirtland Mary	10							●	●	●	●	●	●				
May Duke	11								●	●	●	●	●	●	●		
Montmorency	11								●	●	●	●	●	●	●	●	●
Richmond	9										●	●	●	●	●	●	

H. L. Price,
Blacksburg, Va.

Blueberry or Huckleberry

It seems not quite settled where the name huckleberry originated as applied to a species of bush fruits of the genus *Gaylussacia*. They grow principally in the Northern hemisphere in North America and North Britain. The plant varies greatly in size from about six inches in height to ten feet. The berries are small, but highly prized for their flavor; not highly profitable commercially because of the amount of labor necessary in picking and marketing. Yet no one who has picked the native wild huckleberry would desire to see them displaced from the markets of the world. Therefore considerable effort has been made to improve the varieties so that they can be marketed profitably in competition with other fruits.

GRANVILLE LOWTHER

Improvement of Blueberries

C. B. SMITH

An investigation of this subject has been undertaken by the Maine station. In a report of that station it is stated that blueberries are found growing in great quantities in many of the Eastern and Northern states on soils which are, as a rule, of little or no value for general agricultural purposes, but that while the berries have been highly prized as an article of food from the earliest colonial period, "practically no attention has been given to the cultivation and systematic improvement of the fruit." Plants have from time to time been introduced into gardens with good results, and the management of blueberry barrens has occasionally been undertaken. An account of an experiment of the latter kind is reported by the Maine station. The blueberry lands described consist of 40,000 acres belonging to one owner.

The land is divided into several parts, each of which is leased to some responsible party who assumes the whole care of burning over the land, keeping off trespassers, harvesting, and marketing the fruit. * * * Every year a certain section of each "lease" is burned over. This burning must be done very early in the spring before the ground becomes dry; otherwise the fire goes too deep and humus is burned from the ground and most of the bushes are killed. Many hundred acres of what would be the best part of the barrens have thus been ruined. The method most commonly used in burning a given area is for the operator to pass around the section to be burned, and drag after him an ordinary torch or a mill lamp. He then retraces his steps over the burned area, setting after-fires in the portions which have escaped, and back-firing if there is danger of spreading unduly over areas which it is desired to leave unburned. A device which was found in use by one party consists of a piece of half-inch gas pipe bent at the end at an angle of about 60 degrees. The end opposite the bent portion is closed with a cap or plug, and in the other end, after filling the pipe with kerosene, is placed a plug of cotton waste or tow. This device is regarded as superior to the lamp or torch as it is more easily handled.

Systematically treated blueberry fields are burned over about once every three years. This burning renews the bushes and tends to check the growth of underbrush.

The early ripening fruits on these lands are picked by hand and sent to the city markets, usually in quart boxes. Later in the season the fruit is sent to the canneries. On the older barrens, especially on areas which are to be burned over the following spring, the fruit is gathered with a "blueberry rake."

This is an implement somewhat similar to the cranberry rake in use on Cape Cod, and may be likened to a dust pan the bottom of which is composed of stiff parallel wire rods. The fruit may be gathered much more quickly and more cheaply by means of the rake. The bushes are, however, seriously injured by the treatment. In no case should the rake be employed in gathering the high-bush blueberries.

At the New York state station considerable difficulty was met with in growing seedling plants of the high-bush huckleberry *(Vaccinium corymbosum)* because of the delicate nature of the young plants and the very careful treatment which they require. The same station made an examination of the flowers of this species in order to learn at what time the stamens yield their pollen.

This seems to be given off immediately before and for a short time after the corolla opens. By opening the corolla of flowers about to expand and jarring the blossoms vigorously over a glass slide, we secured pollen in considerable quantities, which is an indication that the flowers may be at least in part self-fertilized. Nothing appeared in the structure of the flowers to render artificial crossing difficult.

The experience of one grower in Massachusetts leads him to the following conclusions:

(1) It [the high-bush blueberry] does not take kindly to garden cultivation; (2) it is very difficult to propagate from the seed; (3) it is somewhat difficult to graft, but patience and a little of the "know how" will overcome all of these. If grown in the garden, (1) they must be on the north side of a board fence or in the shade of trees and the ground must be mulched with leaves or evergreen boughs; (2) let the seed get fully ripe and drop, then sow in a shady place; (3) graft small bushes at the surface of the ground and cover most of the scion with moist earth.

Success in growing blueberries has been attained by all of these methods.

Another grower reports that he has been very successful in growing high-bush blueberries on a poor, rocky, upland soil. The bushes improved much in thrift and yielded from three to four times as much fruit as wild bushes growing in pastures and swamps and the berries were from 25 to 30 per cent larger. He advises setting plants 6 feet apart each way and mulching with strawy manure in the fall.

The results of the experiments thus far conducted would seem to show that the blueberry is subject to much variation and is greatly improved by cultivation. Blueberries are as yet but little cultivated, but the few attempts that have been made toward their improvement indicate that with care satisfactory results may be obtained. Meanwhile natural blueberry barrens may be made to give increased yields by systematic burning and care, and thus these lands, otherwise worthless for agriculture, made sources of profit.

References

For an account of exhaustive experiments in Swamp Blueberry Culture, see Bulletin 193, Bureau of Plant Industry, by F. V. Colville.

Card, Bush Fruits.

Bailey, New Cyclopedia of American Horticulture.

Brazil Nut

The seeds of a Brazilian tree, called also Castanea, Cream nut, Nigger toe, Para nut. It belongs to the natural order *Myrtaceae*, species *Bertholletia excelsa*. The tree often attains a height of 150 feet, and a diameter of four feet. It has bright green, leathery leaves, two feet or more in length, and six inches in width. It bears cream colored flowers and a very hard shelled fruit six inches or more in diameter, containing about 20 three sided wrinkled seeds, which are used for dessert, confectionery, and for the manufacture of an expressed oil used in oil painting, lubricating fine machinery, and in lighting. This tree covers large tracts of land in Northern Brazil, along the Amazon and Orinoco rivers.

GRANVILLE LOWTHER

Bread Fruit

Artocarpus incisa

A tree of the natural order *Urticaceae*, native of the Indian archipelago and of the Southern Pacific islands. It attains a height of 30 or 40 feet; is often limbless for half its height, bears leathery, glossy dark green, three to nine-lobed leaves, one to three feet long; has compact club-shaped, yellow catkins of male flowers, 9 to 15 inches long, and sub-globular heads of female flowers, with spongy receptacles; and usually seedless, spheroidal fruits, at first green, later brown, and lastly yellow, six inches or more in diameter, hanging by thick stalks singly or in clusters of two or three from the smaller branches. The rough rind is irregularly marked in squares and other figures with raised centers. The unripe fruit contains a milky juice, and when in the edible stage it resembles fresh bread, being white and mealy. It is then slightly tart. Later it becomes yellow, juicy, and tastes of decay. In tropical countries where it has been introduced and particularly in its original home, the fruit is highly valued as a nutritious food, being prepared for use in various ways.

When baked it resembles plantain rather than wheaten bread, being sweetish, slightly astringent, but otherwise almost tasteless. When fresh fruits cannot be procured, it is sometimes slightly fermented, beaten to a pasty mass, and so used.

Another common way of preparing it is to beat it to a paste with cocoanut milk and to serve it mixed with bananas, plantains, etc. Since the trees produce two or three crops annually, and since the bearing seasons of different varieties overlap more or less, the fruit may be obtained during the greater part of the year. Not alone for the fruit is the tree valuable; in the South Sea islands its fibrous inner bark is woven into cloth resembling, but inferior in softness and whiteness to that made from the paper mulberry which is similarly employed in those islands; the gummy exudation from the bark, boiled with cocoanut oil is used for caulking canoes, pails, etc.; the beautiful yellow wood is light and soft, but when exposed to the air becomes dark like mahogany, and is used for canoes, furniture, and the interior work in houses.

The tree has been cultivated to a slight extent in Southern Florida, but the fruits rarely appear even in the most southern markets of the United States, because they do not bear shipment well, and unless used very soon after being gathered become hard and disagreeable in taste. For an account of the introduction of the bread fruit tree into the West Indies in the last decade of the 18th Century, when such feats were more difficult and less common than a century later, see Curtis' "*Botanical Magazine*" (pp. 2869-71). A near relative of the bread fruit trees is the jack.

The Americana Bread Nut

Brosimum alicastrum

A tree of the natural order *Urticaceae*, a native of the West Indies and closely related to the bread fruit. The tree, which is very large, bears shining lance-shaped leaves; globose catkins of male and female flowers on different trees; and yields a gummy, milky juice from its bark. The round, yellow fruits (drupes), which are about three inches in circumference, contain a single seed. When roasted or boiled they are used like bread, and having a flavor which resembles hazel nuts, form a pleasant food. In the United States the tree has not been cultivated.

THE AMERICANA BROCCOLI, *How Grown in Alaska*. See *Alaska*.

See *Kale*.

BRUSH LAND, *Preparation of*. See *Apple Orchard, Preparation of Ground*.

Brussels Sprouts

This vegetable belongs to the Cabbage family. The stem is usually two or more feet high with leaves, and at the base of each leaf is a small cabbage which is seldom more than two inches in diameter. These miniature cabbages are much more delicate in flavor than the ordinary cabbages, and are the parts eaten. In growing, it requires the same treatment as the cabbage, except that they may be grown nearer together. It is highly esteemed by some persons, as an article of food, but has not come into general use; probably owing to the fact that in our markets, not as much attention is paid to quality as to general appearance. The Dwarf Brussels is the variety most highly recommended.

The plant is a biennial, a native of Europe, and like the cabbage succeeds well on almost any deep rich soil.

Varieties

Scrymger Giant.

Long Island Improved.

For DISEASES AND PESTS, see under *Cabbage*.

GRANVILLE LOWTHER

BUCKWHEAT, See *Apple Orchard, Cover Crops.*

BUDDING, See *Apple, Propagation of; Peach, Propagation of, etc.*

Breeds of Fruits and Their Survival

Plants are coming into as much prominence as are animals by breeding and it is eminently proper to speak of the breeds of farm crops or the breeds of fruits. A breed is the result of domestication, at least we may say so if we apply the term breed to a plant which we have artificially endowed with a pedigree. Perhaps it is taking liberties with the dictionary to call an improved kind or type of apple a breed, but no other word conveys just the meaning I desire. For example, if I speak of the Wealthy apple as a breed of apples we naturally think of the general characteristics of the Wealthy apple and still allow for a considerable variation in different localities due to the action of soil and climate, and it is with special reference to apples that I would speak of the survival of breeds or varieties if you prefer that word.

Fruit growers in the West have come to recognize certain climate and soil areas as suited to particular kinds and varieties of fruits. This is especially true in California, where in one valley or even in one portion of a valley, the farmers determine one particular kind that succeeds best and then grow that kind almost or quite exclusively, while in an adjoining valley or section a different fruit will be grown. So, too, a state, or one particular section of a state, becomes famous for some particular breed of fruit. The California Belle Fleur apple in uniform boxes of uniformly graded fruit now finds its way into many markets. Southwestern Colorado is becoming a Jonathan region. Other parts of the West are growing Wagener, or Spitzenburg, or Rome Beauty, or McIntosh Red, or Wealthy, and so on. At the local apple shows some one variety usually predominates. Of course there are a number of hardy and widely adapted fruits that appear in every exhibition. We nearly always find among the apples given most prominence at the county and state fairs in the mountain region well grown specimens of Yellow Transparent, Duchess, Wealthy, Wolf River, Alexander, Longfield, Northwest Greening, Fameuse, Bietigheimer, McMahon, Gano and others, including most of the large and small crabs. It often occurs at these shows that one or more varieties will be shown that no one is able to name.

In the pioneer days of apple growing, the would-be horticulturist has had no guide and the only judgment with which he made selections of varieties was a memory of some good or favorite kind which he was acquainted with in his boyhood days. Usually he has been more or less skeptical about the success of any domesticated thing which he would transplant to untried soils, and he is ready to try anything new which is called to his attention. Tree agents are not slow about recommending anything of which their nurseries have stock for sale. It is said that some five thousand varieties of apples are known in the world. Of all the varieties planted in any locality, a comparatively small number have survived. Perhaps hundreds of Wyoming ranchmen and farmers have purchased and planted quince and apricot trees, but I have yet to hear of or see a ripe fruit of either quince or apricot in this state. Of the hundreds of varieties of apples the successful commercial kinds may be counted on the fingers of both hands for the whole state.

There are several reasons why the many varieties do not survive. In the first place fruits are more or less domesticated and they are transferred to a new region before the soil has been tamed and made ready for them. Then the western pioneer has been doing things in a large way and generally fails to attend to the necessary little details of plant culture. Someone has said that those plants which require the most care are given the best cultivation, inferring that the apple is so easily grown that it is subjected to general lack of care and neglect and this condition has certainly fitted our attempts in the mountain region. Finally, the reason of most importance, perhaps, is that difficult to define something in the plant constitution called adaptability.

We look upon plants and animals as creatures of environment. They are what they are because of certain conditions of food supply along with climatic and social influence. But organic life has within itself an inherent power of variation and adaptability which enables some individuals or species to survive under changed conditions of life and food supply. The fact that characteristics may appear in one place that fit a plant for life in a different environment is now recognized. The great Dutch botanist and plant breeder, DeVries, goes so far as to advocate that most of the desert flora is probably made up of varieties that had their origin by mutation in a more favorable location and by migration have found a home in the arid soils which they do not enjoy, but which they are able to endure. Under proper irrigation and in soils rich in plant foods, with favorable climate, plants brought to the arid region would seem to have better chance for growth and development than in some of the regions where they originate, but we must recognize that the conditions of life are so different that there must be a large range of adaptability in the species or there must be some dominant character which definitely fits the variety to this different environment, or it will fail. In my opinion these characteristics are much more apt to appear in the region during the time the plant is growing under those particular conditions, and herein lies the reason for securing our plants or seeds at home or at least from a place where the conditions are not less severe.

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*B. C. Buffum, in Address before Wyoming State Board of Horticulture.

Bud Worm. See *Peach Twig Borer.*

Buffalo Berry

Lepargyrae argentea, Greene
Shepherdia argentae, Nutt.

The buffalo berry is a tall shrub or small tree, a near relative of the Russian olive which it resembles in its silvery foliage and yellowish flowers. The fruit is rather sour, slightly resembling that of ripe cranberries, spherical in shape, about the size of large currants or small gooseberries, and of a reddish color. The tree is very hardy, with thorns that enable it to grow where other small fruits would be destroyed by stock, or other unfavorable surroundings. However, it is not largely cultivated, because in competition with other fruits like currants, gooseberries, blackberries, raspberries, etc., it seems not to be preferred by the trade.

F. W. Card, in the New Cyclopedia of American Horticulture, says: "The buffalo berry has long been before the public, but it is only within the last few years, that it has attained any prominence as a fruit plant. In Hovey's Magazine of Horticulture for 1841, page 251, it is mentioned as frequently cultivated, indicating that it had found its way into our gardens earlier than the blackberry. Its position today bears evidence that no such place was awaiting it as stood ready for the blackberry, or that if there were, it has lamentably failed in filling it. The plant did not find its place as a cultivated shrub until the settlement of the West created a demand for hardy and drouth resisting fruits."

It is the hardy drouth resisting qualities of this fruit that has brought it into prominence in the mountainous and semi-arid regions of the West. It may therefore be found growing on the semi-arid plains east of the Rocky mountains in Montana, Wyoming, Colorado, New Mexico, Kansas, Nebraska, the Dakotas, and in parts of Canada.

It is very tenacious of life, and is easily propagated by seeds, by suckers, or by cuttings. Its fruit is used mostly for jellies and has a very pleasant taste. As a fruit adapted to conditions where other fruits will not succeed, it has considerable value; but in competition in the markets with fruits grown for commercial purposes, in regions adapted to fruit growing, it will not succeed.

Granville Lowther

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Bush Fruits

After the selection of a proper site for the growing of bush fruits, the most important factor entering into it, is the man. This has been demonstrated so often, and in so many parts of the country, one man succeeding where another fails, that it needs no extended proofs here. We will refer to our article on apples as an illustration showing how by the choice of good varieties, and by the proper care in packing and marketing, one man will make a good profit, while another will barely live. Card in his book on "Bush Fruits," says: "The yield of black raspberries for a given year, as reported by 58 growers ranged from 567· quarts per acre to 9,600 quarts per acre." Just how much of this difference was due to unavoidable conditions, and how much to preventable circumstances, is not known; but our observation leads to the conclusion, that much, very much, depends on the man. "The yield of blackberries per acre as reported by 50 growers, ranged from 1,280 quarts, to 10,000 quarts. The average was 3,158 quarts per acre." The highest yield shows the possibilities of high productions under favorable conditions, the low yield shows what to expect under poor conditions with poor management.

It is conceded that all the bush fruits, except perhaps cranberries, do better in a deep rich soil, well drained, than under other conditions. Perhaps in no section of the United States do berries produce larger returns than in the Pacific coast region. Here, nature seems to have furnished the conditions of soil and climate best adapted to this kind of fruit.

In the Rocky mountain and Alleghany mountain regions it is conceded that a rich loam, with a clay subsoil, is better for most varieties, while for some, a sandy loam is best. Generally, a good corn and potato soil, is good for small fruits. However, for certain kinds of fruits, especially raspberries, a north slope is better than a south slope because they reach a higher development, where the sun is not too hot. A considerable degree of humidity in the atmosphere is also favorable.

The roots of small fruits do not extend so deeply into the ground as the roots of the larger trees like apples and pears, therefore require more moisture near the surface of the soil, and are more quickly affected by drouth.

Fertilizers

It is impossible to tell, without knowing the character of the soil, what fertilizers should be used. Some soils are full of humus, and to add fertilizers of that character would be superfluous. Generally, where there is an abundance of humus, there is a lack of some of the mineral elements necessary to a good crop. Other soils lack humus, because they are located in the arid or semi-arid regions, where vegetation has grown but little. These soils are generally rich in mineral elements, because the soils have not been leached by rains and floods. Some soils are disintegrated lime stone, and to add lime might injure them, while others are disintegrated sand stone or basalt. A soil analysis is necessary in order to know intelligently what to add and what fruits are best adapted to certain conditions.

Selection of Varieties

There are several considerations which should determine the varieties of any particular species of fruit that should be grown.

First. Selection in reference to soil adaptations. Certain varieties of fruits have become adapted to certain conditions. These conditions must be observed if the best results are to be reached. There are varieties better suited to sandy soils, others to clay, others to black loam, and a study of the nature and habits of the species, or variety of the species, before planting, may obviate much disappointment.

Second. Selection of varieties in reference to climate. The U. S. Pomological Society divides the United States and Canada into districts and gives a table of fruits recommended for each district. These recommendations have been made with a good deal of care, and while they might be amended by the State Experiment Station, or by the experience of growers in any particular locality, they nevertheless have much merit, and it would hardly be considered prudent for the amateur fruit grower, to select his varieties, without consulting their tables.

Third. Selection of varieties with reference to altitude. There are places in the United States where 100 feet in altitude will make as much difference in the temperature as 100 miles further north.

Fourth. Selection with reference to frost.

There are three conditions that tend to protect from frost. The first is altitude, or elevation above the surrounding country. This does not mean, necessarily a high altitude; but it means that in relation to the lands around it, there are lower lands, toward which the cold air will gravitate.

The second influence affecting frost conditions is evaporation from large bodies of water. A body of water radiates heat less rapidly than the earth's surface. Therefore, in the autumn, the earth cools faster than the water. When the prevailing winds come from a large body of water as a sea, or lake, the atmosphere in the autumn is warmer from the water surface, thus preventing early autumn frosts. In the spring time, the earth absorbs heat faster than the water surface, thus the breezes coming from the body of water are cooler, and the budding of fruit is delayed beyond the frost period. Examples of this are seen on the Pacific coast, Michigan bordering on the lake, and other portions of country similarly situated.

The third influence affecting frost is air drainage.

To have good air drainage a tract should be so situated that there are no obstructions to the free passage of the cold air downward. A pocket will be frosty. Wherever the air tends to stagnate there will be a tendency to frost. Locations in gaps, gorges or canyons opening out into valleys or broader spaces afford good drainage as there is usually a movement of air forced by the pressure from the higher lands and the broad opening permits a free escape. This circulation of air tends to prevent the frost from forming.

Fifth. Location with reference to markets.

It makes a great deal of difference, in handling tender and perishable fruits, whether they are hauled or shipped long or short distances. A long haul, over the ordinary country roads, often bruises and injures the fruits, so that when they reach the local market, they are unsaleable. A long distance shipment takes time, and in that time, the fruits are more or less damaged. Besides the extra expense of a long shipment there are dangers of delays, wrecks and other losses, that often cause trouble. Other things being equal, it is much better to have an orchard near the markets.

For the different varieties of bush fruits treated, see under their respective names:

Blackberry, currant, gooseberry, huckleberry, raspberry.

GRANVILLE LOWTHER

By-Products of the Apple

The utilization of cull and possible surplus apples is a matter of economic importance, and may, in many instances, mean a difference between profit and loss in the apple business. Just as the great packing concerns utilize every particle of their raw material and allow nothing to waste, so can the grower utilize his cull apples in many ways and check or prevent waste. There is a special use for every part of the apple. Seeds are used by large nurserymen for growing apple seedlings. The skin and core are preferred by the jelly makers on account of high sugar content and the coloring matter of the skin. The pulp or flesh is used for canning, evaporating, apple butter, apple paste and other products But the greatest value is in the juice.

The maker of juice products strives first of all to get the greatest possible amount of juice from his apples. The amount of juice that the apples contain depends upon the condition of ripeness, as well as upon the variety. An over ripe apple is mealy and contains less juice than one in prime condition. Also certain varieties such as Jonathan and Winesap contain more juice than certain other varieties, such as Maiden Blush and Rome Beauty. A bushel of good cider apples in prime condition should contain from four to five gallons of juice. The amount of juice that is actually taken out depends largely upon the efficiency of the machinery. The large hydraulic presses with a pressure of from three to five hundred tons seldom get more than four gallons to the bushel, while the small hand presses seldom get more than two and one half gallons to the bushel. Just as the last strippings of a cow's milk is the richest part of her milk, so the juice that is left in the pomace after the first pressing is the richest of the juice. In fact after the first pressing by the best presses it is figured that from 25 to 40 per cent of the sugar content still remains in the pomace. We shall see as we proceed that the sugar content largely determines the quality of the juice, for most of the products made therefrom. The pomace therefore, is very often soaked up and repressed.

The products of apple juice may be discussed under three main divisions as follows: Plain apple juice or sweet cider, reduced apple juice, and products of fermentation.

Sweet Cider

It would seem that the simplest marketable product of apple juice is sweet cider, which is the juice just as it comes from the press. It is a simple matter to make sweet cider, and it is a marketable product for which there is a good demand. But it is not such a simple matter to keep cider sweet, without in some way impairing its quality. In fact this difficulty of properly preserving sweet cider has undoubtedly been the greatest barrier to the proper development of the sweet cider business, and likewise the greatest barrier to satisfying the demands of a sweet cider loving public.

Difficulty of Keeping Cider Sweet

In order to understand something of the cause of the difficulty of keeping cider sweet, it is necessary for us to know something of the composition of apple juice, the processes of fermentation and the organisms which cause fermentation. This will be explained more fully in discussing the products of fermentation. It is only necessary here to explain that certain minute organisms enter the juice immediately upon its being exposed to the atmosphere. Under ordinary conditions these organisms develop and multiply rapidly and in doing so transform the sugar of the juice into alcohol. When the formation of alcohol has begun still other organisms enter and change the alcohol into acetic acid. It can be readily seen then that the problem which the sweet cider man has to solve is the controlling or stopping of the work of these organisms.

The general practice for many years has been the use of such chemical preservatives as benzoate of soda, boric acid and salicilic acid. Benzoate of soda is undoubtedly the preservative that is in most general use, and probably the one that gives best results, so far as chemicals are concerned. But even benzoate of soda comes far from giving entire satisfaction. Its use impairs the quality of the juice and does not completely prevent fermentation. Its use is limited by the pure food laws to 1/10 of 1 per cent.

Recent investigations by the United States Department of Agriculture have proven the feasibility of other and better methods of preserving sweet cider. The first of these is the cold storage method. It is well known that these ferment organisms do not thrive at a low temperature. Under this method the cider is taken immediately from the press and cooled rapidly to 32 degrees Fahrenheit, and is then held in storage at that temperature. In the Government tests* the juice was held in this way for from 36 to 70 days without noticeable fermentation and was held for from 90 days to 125 days before being considered "hard" or "sour."

Another method tried out by the Government and which bids fair to come into general use is that of sterilization or pasteurization. By pasteurization we mean heating the juice to a temperature that will kill any of the ferment organisms which may be present. * It was found that to slowly heat the juice to the required temperature gave it a decidedly cooked taste. But a Pasteurizer was devised by which the desired temperature was obtained very quickly, under which condition the cooked flavor is scarcely noticeable.

The Pasteurizer used for this purpose consists of a steam box in which is a coil of pipe. The juice is passed through this coil and can be taken out at any desired temperature, depending upon the rate of flow. It is heated up to 170 degrees Fahrenheit and put at once into sterilized containers, care being taken to avoid any possibility of contamination. It must be remembered that hot juice put into a barrel or other container will shrink upon cooling and thus leave a space at the top of the container. For this reason the containers are not bunged tightly until the juice has cooled. A small hole is bored in the bung. This hole is stuffed with cotton which has been previously soaked in alcohol, so that the air that passes through the cotton is sterilized. When the juice has cooled a wooden skewer which has first been sterilized is driven into the hole and sawed off on top.

Cider preserved in this way should remain sound and sweet indefinitely. In the experiments carried on by the Government the cider was perfectly sound and sweet at the end of six months.

Apple juice may be put upon the market in reduced forms. Cider boiled down to one-fifth of its original bulk has almost the density of syrup. This product is used in making pies, sauces, apple butter and in other cooking. It finds ready sale at good prices in the Eastern markets.

Apple juice reduced to one-seventh or one-eighth its original bulk becomes jelly. Special apparatus for reducing apple juice rapidly is to be had on the open market.

We are now ready to discuss some of the ferments and the products of fermentation. It has been said above that when apple juice is exposed to the air in a moderate temperature fermentation begins almost immediately. Fermentation starts in because certain minute yeast cells which are nearly everywhere have entered the juice and have found an ideal place for their development and multiplication. On this development and multiplication they are doing certain work. They are changing the sugar of the juice into carbon dioxide and alcohol remains in the juice. After fermentation has started but is not yet complete we have what we call "hard cider." By the term "dry cider," or "apple wine," we mean cider that has completed the alcoholic ferment, or, in other words, cider in which all the sugar has been turned into alcohol.

But cider or wine making is not such a simple matter as it might appear. As soon as the alcoholic ferment has begun, if the juice is still exposed to the atmosphere, other ferments which are injurious or destructive to the making of good wine are bound to enter. The thing of primary importance to the cider or wine maker then is avoiding contamination of his liquor.

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*Ref. Cir. No. 48, Bureau of Chemistry, U. S. Department of Agriculture.

*Note, Bul. No. 118, Bureau of Chemistry, U. S. Department of Agriculture.

The juice as it comes from the press is put at once into barrels which have been thoroughly steamed or scalded. The barrel is filled only about three-quarters full to avoid overflowing during the period of tumultuous fermentation.

When the juice has been put into the barrel a fermentation funnel is immediately put into the bung and tightly sealed around the edge of the bunghole with paraffine or vaseline. A fermentation funnel is so arranged that the gases from within the barrel escape, but the air from without cannot enter.

In recent years some of the ferment yeasts have been separated into many varieties and pure cultures made of these varieties. It has been found that fermentation may be hastened by the use of certain pure culture yeasts, and also that the flavor of the wine depends largely upon the variety of yeast used.

After fermentation has been completed the cider is drawn off from the top into freshly sterilized containers, leaving the lees and sediment in the bottom of the old containers. The new containers are tightly bunged and sealed and stored in the cellar ready for use.

Perhaps the product of apple juice which is most extensively made in this country at the present time is vinegar. In the manufacture of vinegar, as in the apple industry itself, quality is of first importance. The element of quality in vinegar is largely determined by the per cent of acetic acid. The law in most states requires vinegar to test from four to four and one-half per cent acetic acid. Much of the vinegar made on the farms, in a haphazard way, not only will not stand this test but, on account of decomposition or other cause, is unfit for use, and does not find a ready market. On the other hand a recent writer on the subject says:

"Apple cider vinegar is demanded by the trade. There is not one-tenth enough pure cider vinegar made in this country today to supply the ever-increasing demand."

To make a good product the vinegar maker must first have pure apple juice which must test not less than nine per cent sugar; 10 per cent to 12 per cent is much better. It is upon this sugar content of the juice and its subsequent chemical changes from sugar to alcohol and from alcohol to acetic acid that the manufacture of vinegar depends.

(1) Sugar = Alcohol + Carbon Dioxide
$C^6H^{12}O^6 = 2C^2H^6O^2 + 2CO^2$

[Water
(2) Alcohol + Oxygen = Acetic Acid +
$C^2H^6O \quad + O \qquad = C^2H^4O^2 + H^2O$

Theoretically, to get a four per cent acid vinegar requires a cider containing four per cent alcohol. And to get a cider containing four per cent alcohol we must have a juice containing eight per cent sugar. In practice it is best to leave a little margin above these figures to allow for incomplete chemical change or waste.

The vinegar maker therefore strives to get a juice as rich as possible in sugar content. The sugar content of the juice depends upon the conditions of ripeness of the apples as well as upon the variety. While an apple that is underripe has not yet changed its starch to sugar, an apple that is overripe has in some peculiar manner lost some of its saccharine substance. An apple must therefore be in prime condition of ripeness to show highest sugar content of juice.

Many tests of varieties have been made, and published lists of the sugar content of different varieties are to be had. It is a simple matter for anyone to make this test with a saccharometer. In practice, however, the vinegar maker seldom has the chance to select his varieties, but must take a mixture of the varieties as they run. It is enough here to say that the average mixture of varieties, if in good condition, will test sufficiently high, and that our favored winesaps and Jonathans are both high-testing varieties.

The minute organisms that are responsible for changing the sugar content of apple juice to the acetic acid of vinegar require special conditions in order to thrive and do their work. The practice of modern vinegar making has been greatly facilitated by a knowledge of the habits and requirements of these organisms, and a proper manipulation of the juice to fill these requirements. The yeast plant, which, as has been stated above, is responsible for the alcoholic ferment, thrives best in a temperature of 75 degrees to 85 degrees Fahrenheit. If the storage room be kept at this temperature the alcoholic ferment should be completed in about four weeks. Special yeast cultures are sometimes used to hasten the process.

The acetic ferment, or the bacteria, that are responsible for the chemical change of alcohol to acetic acid require oxygen in order to thrive and to do their work, and the cider must therefore come in contact with the atmosphere. Since only the surface of the cider in a barrel comes in contact with the air it is only upon the surface that the acetic ferment works. For this reason the old system of allowing the cider to stand in barrels until it becomes vinegar requires a period of many months, usually about two years.

The modern vinegar maker hastens matters by passing his cider through a "generator." A "generator" is a tall tank having a perforated false bottom some eight to ten inches from the real bottom, and a false head a few inches from the top of the staves. The space between the false bottom and the false head is filled with rattan or beachwood shavings, or some other suitable material. Just above the false head the cider is fed into a little trough, which automatically dumps and spreads the cider over the perforated head. This allows it to trickle down through the shavings, thus exposing every drop to the air. In this way the same process which requires two years in the barrels is accomplished in a single day. However, for the average orchard man the old barrel process is still probably the most practical. Even this process may be very much shortened by a proper manipulation of the cider in the barrels. It may be racked off into new barrels frequently and in that way thoroughly stirred and exposed to the oxygen of the atmosphere.

The ideal temperature for the acetic ferment is about 86 degrees Fahrenheit. That is the bacteria is most active at this temperature and becomes less active as it varies either way from this. At 104 degrees Fahrenheit their action ceases entirely.

Upon completion of the vinegar process the vinegar maker takes every precaution to check further chemical change or decomposition. He puts the finished product in pure, clean, barrels carefully guarding against the presence of vinegar eels or other foreign matter. The barrels are then tightly bunged and his product is ready for the market.

P. S. Darlington,
District Horticultural Inspector.

Cabbages

The parent from which the variety of cabbages in common use has sprung is supposed to be the wild sea cabbage *(Brassica oleracea)*, a plant found near the seacoast of various parts of England and continental Europe. The cultivated varieties vary greatly from the original type, but present striking similarities amongst themselves. There are some points however, in which the wild and the cultivated are nearly alike and these are in the flower seed pod and seed.

Cabbages contain a very small per cent of nitrogenous compounds as compared with most articles of food. An analysis when cooked will show that they generally contain chemical constituents as follows: Water, 97.4 per cent; fat, 0.1 per cent; carbohydrate, 0.4 per cent; mineral matter, 0.1 per cent; nitrogenous matter, 0.6 per cent; cellulose, 1.3 per cent. They are said to possess anti-scorbutic properties. Apart from that, the analysis shows that they have very little food value.

The Soil

Cabbages require a deep rich soil, where they can be made to grow rapidly and be crisp and tender. Almost any good soil that will grow corn, vegetables and other crops successfully will grow cabbages; but with some vegetables it is possible to get the soil too rich while with cabbages there is little danger. The Pacific Northwest is well adapted to the growing of cabbages, and in the low lands of the eastern side of the Cascade mountains, where irrigation is practiced and the alkali is strong, excellent cabbages can be grown on land too strong in alkali for fruit trees. However, it must not be supposed that all alkali soils would be good for cabbages; for we have seen the alkali so strong that nothing would grow. We only wish to suggest that land sometimes considered waste, because it will not successfully grow fruit trees or hay, may be utilized for cabbages.

For an early crop the seed should be sown in hotbeds, early in the spring, and the plants set in rows in the field or garden as soon as the danger of frost is over. The plants are not tender, and will stand considerable cold, so that it is not necessary to exercise the same care as in case of beans, tomatoes, or some other garden plants. For a late crop the seed may be planted in the open, and the plants set almost any time during the summer. It is not uncommon, in the milder climates, to set the plants as late as September, and allow them to stand in the field as late as December. This method is practiced by many growers, in order to avoid the pests that are much more destructive during the summer than in the autumn.

Setting the Plants

The plants should be set in rows, about three feet apart, so that it is easy to cultivate between them. Some practice the method of cross cultivation, in which case the plants have to be set in squares about three feet each way, and the rows both longitudinal and transverse. Plants should be set in the evening, and the ground about them well watered, so as to keep the roots wet and the plant sappy during the next day, until the little tender root hairs begin their work of supply. If plants are not set during the evening, then they should be covered with a leaf, or paper, or something to protect them from the sun. The stem of the plant should be set deeply enough so that the leaves are within an inch or so from the surface of the ground. It is better to set the stem in the earth up to the leaves than to leave too much of it exposed, as is often done.

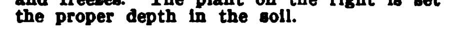

Fig. 1. The Plant on the Left Is Set Too Shallow. The stem is exposed to the sun and freezes. The plant on the right is set the proper depth in the soil.

Varieties

Recommended for the Inland Empire section of Oregon, Washington and Idaho.

Extra Early Express (Burpee), Early Jersey Wakefield (Burpee), Early Winigstadt (Burpee), Surehead (Burpee), American Drumhead Savoy (Henderson).

On the question of varieties for the South we quote from C. C. Newman, South Carolina Agricultural College.

"Contrary to the general opinion, the early maturing varieties are better suited for winter use in the South than the late varieties. If the late varieties are planted at the usual time in the spring, they will mature before fall, and if planted in late summer, they will not mature until midwinter, and are liable to be seriously injured before they are ready to be harvested. In the mountain section where the summers are not too severe, the late varieties, set out in May and June, mature during the months of October and November.

"We have tested practically all the varieties of cabbages in our trial grounds for the last five years, and the Charleston Wakefield, Early Summer Succession, and Late Flat Dutch, have given best results for fall and winter use, when planted to the field the first week in August. There are, of course, a large number of varieties that will produce fine fall cabbages, but the three mentioned seem to be about the best for this section of the country. The two first named varieties will mature during October and November, and the Succession will form large solid heads by the middle of December. The late Drumhead Savoy will probably endure more cold after heading than any of the smooth leafed varieties, and is, therefore, very desirable for a very late winter cabbage. It is highly recommended for home use and for local markets. Late Flat Dutch is an excellent variety to follow Succession. Cabbage here will endure a temperature of 26 degrees without injury.

"Cabbage seed sown in an unprotected bed about October 1st will produce nice, stocky plants for transplanting to the field in early spring. Seed sown at this time will make short, stocky plants, which will head from May to July, according to the earliness of the variety. Seed sown in the open ground about the first of September will usually make too much growth before cold weather, and are liable to run to seed when transplanted in the spring, without forming heads. Seed sown in protected frames early in January will be ready for transplanting to the field early in March. Before transplanting, these plants should be gradually hardened off by exposing them to the cool weather and allowing the bed to become moderately dry. Cabbage plants set to the field in October will not be injured to any great extent, even during the coldest weather. The plants will make considerable growth during October and November, but from the last of December to the last of February little growth will take place. After the first of March the plants begin to grow more rapidly, and by the first of April they will begin to form heads. When the plants are set out too early in the fall, they will form small heads by the middle of December, and a large per cent of the plants will run to seed in the spring, without forming marketable heads.

"The following table gives some idea as to what might be expected from an acre of fall cabbages:

Year 1908

Variety	Seed Planted	Plants set to field	Per cent. of plants died	When matured	Average Weight	Per cent. of plants that headed	Yield per acre
Charleston Wakefield	June 3d	Aug. 15	5%	Nov. 1 to Dec. 5	3 lbs.	95%	12,630 lbs.
Henderson's Success'n	June 3d	Aug. 15	6%	Nov. 10 to Jan. 1	6¼ lbs.	92%	23,490 lbs.
Late Flat Dutch.....	June 3d	Aug. 15	8%	Nov. 25 to Jan. 15	6 lbs.	85%	18,480 lbs.

"The soil on which these cabbages were grown would produce about 40 bushels corn per acre.

"Ten two-horse loads of stable manure was applied broadcast per acre, and the soil was then plowed eight inches deep with a two-horse turn plow. One thousand pounds of fertilizer, analyzing eight per cent phosphorous acid, four per cent nitrogen, and seven per cent potash, was then applied broadcast, and mixed with the soil with an Acme harrow."

Harvesting the Crop

When mature, if cabbages are grown for the markets, they are generally pulled, some of the outer leaves taken off, the stems cut off, and they are then crated for shipment. If they are grown for home use, they are treated in like manner and stored in a cool place, the nearer to the freezing point the better. Sometimes the farmer pulls his cabbage late in the autumn or early in the winter, and places them in trenches with the stems

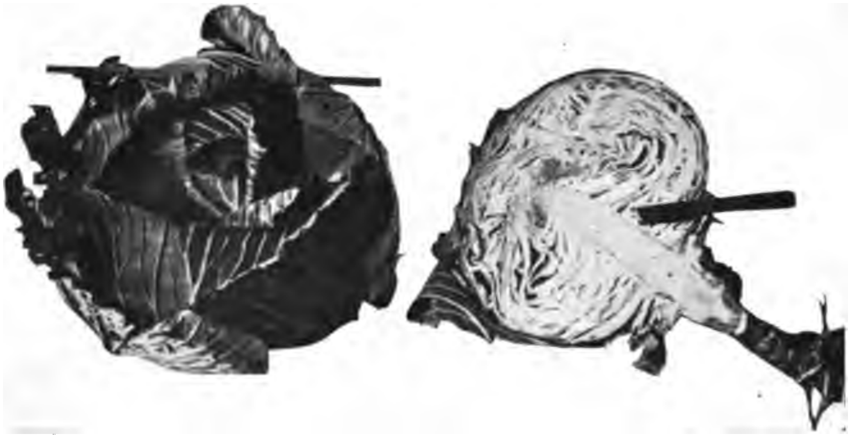

Fig. 2. Two Heads of Succession Cabbage Cut From the Field After Having Withstood a Temperature of 20 Degrees.

upward, throwing a little dirt over them and taking them out as they are needed for use. When the winters are mild, we have known cabbages left in the field all winter to be in fairly good condition the following spring. **Granville Lowther**

Wide Variation in Price of Cabbage

Of the 40 different agricultural products, the prices of which are obtained monthly by the department of agriculture, cabbage varies most widely in price. For the entire United States the average price paid to producers on January 15 was about $1.26 per 100 pounds. This average is based upon reports of correspondents from 778 towns, representing every state of the Union. The lowest average for any state is 24 cents per 100 pounds for New York. The highest average is $3.33 per 100 pounds for Alabama. The average of 24 cents per 100 pounds in New York is based upon reports from 23 towns, eight of which returned 15 cents per 100 as the average; no quotation was above 50 cents per 100 pounds. In the adjoining state, Pennsylvania, the average price was about $1.60 per 100 pounds, not one of the 23 reports received being under $1 per 100 pounds. Here is an average difference of $1.36 per 100 pounds in the average price paid to producers of cabbage in two adjoining states.

Crop Reporter, January 1, 1913.

Cabbage Methods of Propagation in Alaska. See *Alaska.*

For **Propagation in the Gulf States** see *Alabama.*

CABBAGE DISEASES

Black Leg or Phoma Wilt

Phoma oleracea

F. D. Bailey

This is a serious disease of cabbage and cauliflower. Though it has only recently been reported in the United States, it has already become widely distributed. In Ohio many fields have been seriously damaged, in some, indeed, the disease was so severe that no marketable cabbage were cut. It is supposed that this disease was introduced from Europe where it has caused severe losses, especially in France, Germany and Holland. It has been known in Australia for a number of years and is thought to be the most serious disease affecting cauliflower and cabbage in that country. This disease has been found in Oregon, during the season of 1912, in Jackson and Wallowa counties. In the latter, where it probably appeared the previous year, it is already causing alarm. It is very probable that the fungus may be introduced on seed, and it is interesting and possibly significant to note that the Wallowa grower purchased his seed from Illinois the year he first observed the disease.

Symptoms

The most characteristic symptom of this disease is the blackening and decay of the stem close to the surface of the ground. (Fig. 1.) Cankered areas are produced which sometimes completely girdle the stem and the plant is often broken over by the wind. The outer leaves of affected plants are bluish red in color, a characteristic which remains until the plant dies. Plants may be attacked at any time in their growth, more often, however, when they are about one-half grown.

Other symptoms are spots on stem and leaves, in which numerous very small black specks can be seen. A wilting, in which the leaves droop instead of falling off, is frequently observed in diseased plants.

Cause

The fungus which causes black leg of cabbage and cauliflower is known technically as *Phoma oleracea.* It enters the plant at some place near the surface of the ground, probably in wounds made by insects. Leaf infection may also take place. From these infected spots the fungus spreads, killing the plant tissues and shutting off the food supply from other parts. It comes to the surface to form the pycnidia or small black specks in which great numbers of minute spores are produced. These spores are forced to the surface and are carried by wind, water, insects or other agencies, to start new infection. Many seedlings are infected at planting time. If an occasional diseased seedling is handled, spores will be transmitted to the hands and later to healthy plants. The disease is frequently found closely associated with the wounds and injuries of insects, though infection may take place without aid from this source.

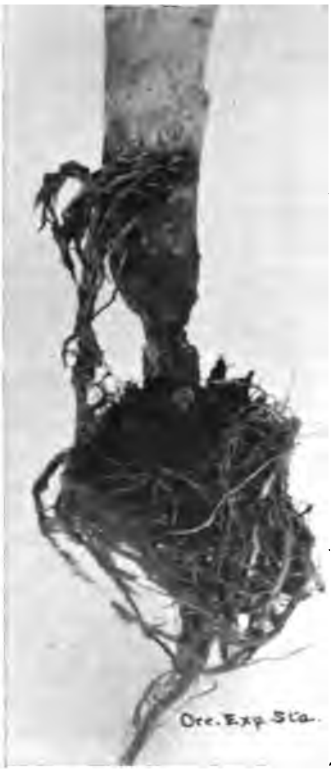

Fig. 1. Black Leg of Cabbage. The stem is often girdled near the surface of the ground.

Treatment

The black leg organism is doubtless carried over in the stems and leaves of old decaying plants. It is a fungus capable of living in the soil, but one that can be controlled if the proper measures are constantly employed. The greatest care should be taken to keep the seed bed free from it, thus making certain that it does not become distributed over the fields. The recommendation is made in Ohio that the seed beds be sprinkled with 4-4-50 Bordeaux at the time of planting, using one gallon of the mixture to each 10 square feet. This operation should be repeated two weeks before transplanting and again just before transplanting. This method has proven effective in holding the disease in check. It is better to select clean ground for the seed bed each year and disinfect the seed to be used. A safe treatment for cabbage and cauliflower seed is to use a solution of formalin, one-fourth pint in seven gallons of water, allow them to soak for 15 minutes, rinse in clean water and spread out to dry.

When the disease appears in the field the affected plants should be removed and burned.

The truck growers of the Northwest may well be on the lookout for this disease. It must be dealt with intelligently from the first, for, once established, the disease is a difficult one to control.

Brown or Black Rot

Bacterium campestre (Pam) Erw. Sm.

Is a serious disease of these two crucifers, and attacks others of the family, including turnips. It is a veritable scourge to the cabbage growers of Ohio and other states. Smith (Farmers' Bul. 68, U. S. D. A.) has published concerning it and has attributed the disease to a specific germ. The diseased heads may be dwarfed, in portions rotted, and brown colors will appear in the woody layers of the plant, including the stem. Badly diseased heads emit a penetrating and offensive odor. The losses from the brown rot have been very large and specific remedies cannot be stated. The author quoted sums up the subject of treatment in one word—prevention. The measures recommended are—plant on new land and only from healthy seed beds; avoid succession of the same crops; avoid stable manure and give preference to artificial fertilizers to escape possible infection through the manure. Prevent animals from cropping in diseased fields. Clean tools by scouring bright after use in infected soil. Fight the cabbage insects, since these inoculate healthy plants with the disease. Removal of badly affected plants, or newly infected leaves, at intervals, and subsequent burning or deep pitting of this refuse may aid in checking brown rot. Destroy all mustard weeds.

The water pores of the cabbage are large, as is evidenced by the great amount of water which collects on the outside of the leaves under certain conditions, which makes the cabbage quite susceptible to this form of disease.

A. D. Selby,
Wooster, Ohio.

Club Root

Plasmodiophora brassicae

F. D. Bailey

This is a destructive root disease of crucifers attacking, among the cultivated crops, the cabbage, cauliflower, turnip, etc. It is caused by a very minute organism belonging to the group Myxomycetes, commonly referred to as the slime moulds. The technical name of the organism causing this disease is *Plasmodiophora brassicae*. This disease occurs in various sections of the Northwest, but cannot be considered to be a very common trouble. The knotty swellings or club-shaped enlargements (Fig. 1) resulting from the invasion of roots by this fungus prevent the normal growth of head or root and gradually kill the plant.

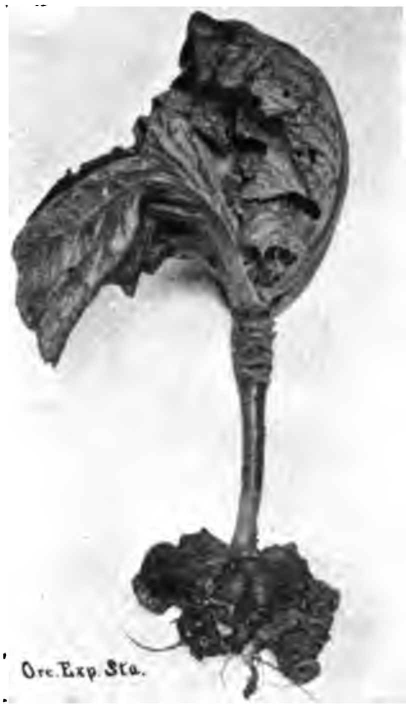

Fig. 1. Cabbage Plant Affected With Club Root.

When once established in the soil, the fungus will live for several years. Certain weeds, shepherd's purse and hedge mustard, are good hosts and doubtless furnish opportunity for the disease to perpetuate itself and to spread.

Control

Care must be taken to keep the seed beds clean. Destroy all refuse from diseased plants. Do not allow such material to get into the compost heap. Practice rotation with crops not included in this group of plants, and keep the weeds down.

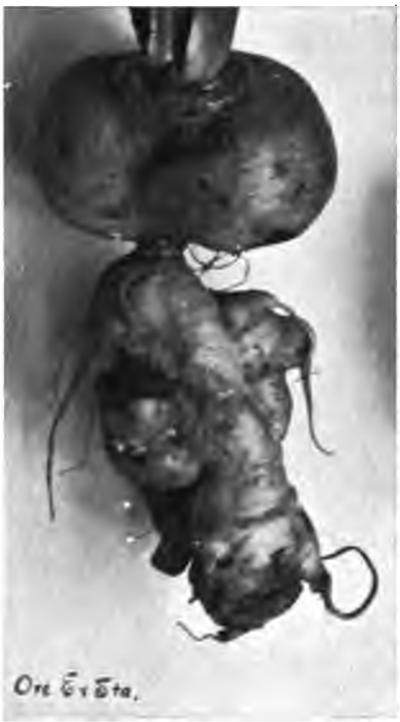

Fig. 2. Club Root on Turnip.

Experiments have shown that an application of lime at the rate of about 100 bushels per acre when the land is plowed in the spring is a reliable method of control.

Damping Off

Caused by soil fungi of several varieties. The young plants slough off at the ground. The trouble occurs when they are crowded or conditions are too moist. Surface soil should be given a chance to dry. Mainly a seed bed trouble.

Downy Mildew, Leaf Blight and White Rust

Occur upon plants of the mustard family, including the cabbage.

If treatment seems necessary use Bordeaux mixture.

Fusarium Wilt

This trouble has become very destructive in the cabbage growing sections of the Eastern states and bids fair to rank with black rot in importance. It causes a yellowing and wilting of the plants. The only remedy suggested is the breeding of resistant stocks.

Root Rot, Stem Rot, Rhizoctonia

Due to the same fungus which attacks the potato. It would seem that general sanitary measures and rotation is the only practicable remedy.

Bibliography for Cabbage Diseases and Diseases of Crucifers Generally

1898. Vermont Experiment Station Bulletin No. 66.

1911. Virginia Polytechnic Institute Bulletin No. 191.

1911. Ohio Experiment Station Bulletin No. 228.

1912. United States Department of Agriculture Farmers' Bulletin No. 488.

Literature on Diseases of Cole Crops Bulletins and Reports

The following literature was compiled by the Cornell station in Bulletin No. 292.—Ed.

Soft Rot, or Stump Rot

Bacillus carotovorus Jones

1901—A soft rot of carrot and other vegetables.—L. R. Jones (Vt. Rpt. 13 [1900], pp. 299-332, figs. 10).

1904—A bacterial disease of the cauliflower and allied plants.—F. C. Harrison (Ont. Agr. Sta. Bul. 137, pp. 1-28, figs. 18).

1909—The bacterial soft rots of certain vegetables. I.—H. A. Harding, W. J. Morse and L. R. Jones (N. Y. State Tech. Bul. 11, pp. 251-368, figs. 10).

Black Rot

Pseudomonas campestris, Pammel, Erw. Smith

1890—A bacterial disease of cabbage.—H. Garman (Ky. Rpt. 3, pp. 43-46).

1898—A bacterial rot of cabbage and allied plants.—H. L. Russell (Wis. Bul. 65, p. 39, figs. 12).

1898—A bacterial disease of cabbage and allied plants.—H. L. Russell (U. S. D. A. Office Exp. Stas., Bul. 49, pp. 86-89).

1898—Black rot of the cabbage.—E. F. Smith (U. S. D. A. Farmers' Bul. 68, p. 22).

1904—Combating the black rot of cabbage by the removal of affected leaves.—F. C. Stewart and H. A. Harding (N. Y. State Bul. 232, pp. 43-65, pls. 2).

1904—Vitality of the cabbage black rot germ on cabbage seed.—H. A. Harding, F. C. Stewart and M. J. Prucha (N. Y. State Bul. 251, pp. 177-194).

1905—Some bacterial diseases of plants prevalent in Michigan.—W. G. Sackett (Mich. Bul. 230, pp. 213-216, figs. 2).

1909—Some bacterial diseases of plants. —W. G. Sackett (Colo. Bul. 138, pp. 15-18).

Club Root

Plasmodiophora brassicae Wor.

1893—Club root of cabbage and its allies.—B. D. Halsted (N. J. Bul. 98, p. 16, figs. 13).

1893—Injurious insects and diseases of plants, with remedial measures.—W. B. Alwood (Va. Bul. 24, p. 12).

1896—Prevention of cabbage club root. —F. C. Stewart (N. Y. State Rpt. 1895, pp. 525-529).

1898—Susceptibility of varieties of turnips to club root; experiments with cabbages, etc.—B. D. Halsted (N. J. Rpt. 1897, pp. 270-276, fig. 1).

1898—Club root and black rot.—L. R. Jones (Vt. Bul. 66, pp. 3-12, figs. 5).

1907—Some important plant diseases of Washington.—W. H. Lawrence (Wash. Bul. 83, pp. 6-9, fig. 1).

Root Rot or Stem Rot

Corticium vagum B. & C. var. *Solani* Burt.
(Rhizoctonia)

1899—Three important fungous diseases of the sugar beet.—B. M. Duggar (N. Y. Cornell Bul. 163, pp. 339-352, 361, pls. 3, figs. 5).

1900—The rotting of greenhouse lettuce.—G. E. Stone and R. E. Smith (Mass. Bul. 69, pp. 16, 17, 39, figs. 3).

1901—The sterile fungus Rhizoctonia.—B. M. Duggar and F. C. Stewart (N. Y. Cornell Bul. 186, pp. 27, figs. 9). [Ibid., N. Y. State Bul. 186.]

1904—Potato failures.—F. M. Rolfs (Colo. Bul. 91, pp. 33).

1905—Rhizoctonia (Rosette). — G. P. Clinton (Conn. Rpt. 1904, pp. 325-326, pl. 1, figs. 3).

Downy Mildew of Crucifers

Peronospora parasitica (Pers.) DeBary

1891—Cabbage.—B. D. Halsted (N. J. Rpt. 1890, p. 349).

White "Rust" of Crucifers

Cystopus candidas (Pers.) Lev.

1901—The white mould of radish.—B. D. Halsted (N. J. Rpt. 1900, pp. 462, 463, pl. 1).

Bulletins covering generally the treatment of cabbage diseases:

1904—Cabbage diseases and insects.—J. B. S. Norton and T. B. Symons (Md. Circ. Bul. 58, pp. 10, figs. 6).

1909—The control of malnutrition diseases of truck crops.—L. L. Harter (Va. Truck Sta. Bul. 1, pp. 4-16, figs. 4).

1910—Diseases of garden crops and their control.—N. J. Giddings (W. Va. Bul. 123, pp. 18, pls. 5).

1910—A brief handbook of the diseases of cultivated plants in Ohio.—A. D. Selby (Ohio Bul. 214, pp. 307-456+vii, figs. 106).

1911—California plant diseases.—R. E. Smith and E. H. Smith (Cal. Exp. Sta. Bul. 218).

CABBAGE PESTS

Cabbage Aphis. See *Aphids;* also *Cabbage Louse*, this section.

Cabbage Curculio

Ceutorhynchus rapae, Gyle.

Feeds upon the edge of the leaf. Not serious as yet and not in the Northwest so far as known.

Cabbage Hair Worm

Mermis albicans Deising

Looks like a piece of basting thread. White in color, coiled or coiling and uncoiling or crawling on cabbage heads. From two to nine inches long.

Exaggerated reports of poisonings from the presence of this worm came from the South some years ago.

The worm is entirely harmless.

Reference

Bu. Ento. Circ. No. 62, Revised.

Cabbage Louse

Aphis brassicae Linn.

General Appearance

Dark greenish yellow to brownish, with dark transverse bands across the abdomens of some individuals. All covered with a fine white powder, which gives them a silvery or frosted appearance.

Life History

The lice appear with the first plants in the spring and increase with such rapidity as to soon almost entirely cover the host. This condition prevails throughout the early summer, after which the parasites begin to reduce their numbers. It is a disgusting pest on cabbage, cauliflower and brussels sprouts.

Food Plants

All members of the *Cruciferae* including cabbage, cauliflower, brussels sprouts, mustard, radish, etc.

Natural Enemies

The ladybird beetles, *Hippodamia convergens*, *Megilla maculata* and *Coccinella californica*, prey to some extent upon this pest. The real check, however, is the internal parasite, *Diaeretus californicus* Baker.

E. O. Essig

Cabbage and Radish Maggot

Phorbia brassicae Bauche

A. L. Lovett

This insect is considered a very serious pest throughout the Pacific Northwest, or wherever cabbages and radishes are grown. In the truck crop regions, where these crops are grown over considerable areas and for a period of years on the same soil, the pest is especially serious.

Plants Attacked

Besides attacking the cabbage and radish, this maggot feeds on the turnip, cauliflower, celery, rape, kale, and a variety of the closely allied Cruciferiae. It is also found about the roots of some of the wild plants of this group, including mustard and radish.

Description

The Larva.—It is as a larva that the cabbage maggot is injurious and hence best known to the grower. At this stage it is a footless grub or maggot (see Fig. 1), waxy white or yellowish in color. The body is cylindrical, ending bluntly behind and tapering to a point at the cephalic end. When mature, it measures about .32 of an inch in length.

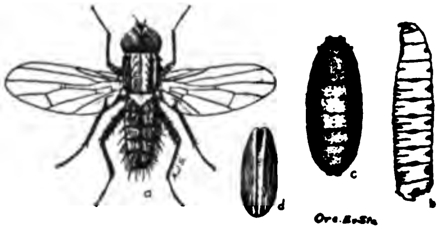

Fig. 1. The Cabbage Maggot (*Phorbia brassicae*), a, adult fly; b, got; c, puparium; d, the egg (much enlarged). (Original.)

The Pupa.—The pupal or resting stage of the cabbage maggot is passed in the soil about the roots of the infested plant. Exceptions to this rule occur in the forms which assume the aerial habit and in the few which pupate in their burrows in the root. The pupa consists of a small brown case or puparium some two-tenths of an inch in length, elliptical-ovate in form and without the ability to move.

The Adult.—The adult insect varies considerably from the maggot that destroys the plant. It is a fly which appears to the ordinary observer not unlike the common house fly. It is considerably smaller in size, however, and when at rest the wings extend a greater distance back of the abdomen and overlap more.

The Egg is really very small, measuring only .04 of an inch in length. It is white, however, and by the keen observer may be readily seen lying on the soil close to the stem of the host plant.

Life History

This insect passes the winter as larvae and pupae in and about the roots of their hosts. Possibly some of them pass the

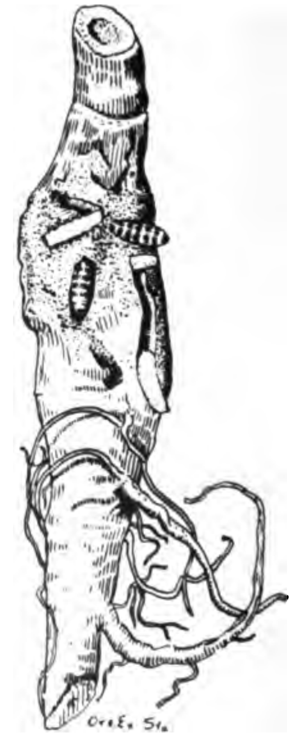

Fig. 2. The Cabbage Maggot. Root of wild mustard showing larvae, pupae and injury.

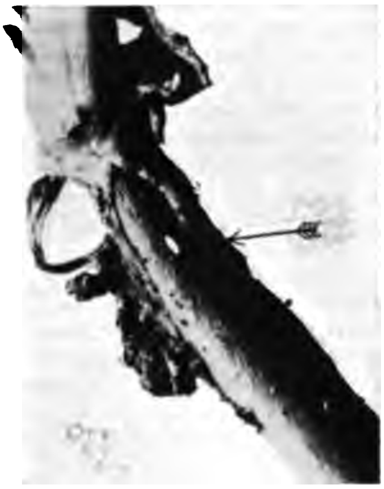

Fig. 3. The Cabbage Maggot. Radish showing egg.

winter also as adult flies, hibernating in sheltered nooks about the field and in outbuildings. As the warm days of spring advance, the flies emerge from their hibernating quarters and also from the pupal cases in the soil, and seek their host plants for the purpose of egg deposition. The eggs are deposited close about the plant, the female fly working herself down below the surface, if the soil will permit, and placing the egg right against the plant root (see Fig. 3). The eggs are often placed above ground on leaves or developing buds. The eggs hatch in from four to ten days, depending on the temperature, and the young larvae commence at once to burrow into the tender plant (see Fig. 2). The maggots reach maturity in a month to six weeks, pupate and emerge soon after as adult flies. From this time on until late fall one may usually find both larvae and pupae in the soil. As the season advances, a portion of the maggots assume an aerial habit. This is especially true in the fields when early cabbage has been harvested and where the stumps left standing have put out adventitious buds. The flies deposit eggs in these tender buds and the maggots burrow into the midribs of the leaves and into the core of the shoots.

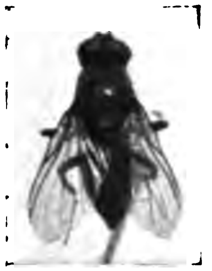

Fig. 4. Cabbage Maggot Adult.
—*Photo by Essig.*

Control Measures

Possibly for no other group of insects will one find such a variety of remedial measures suggested as for the root maggots, nor more diverse results following their application. No single remedial measure will ordinarily afford satisfactory relief. Combinations of preventive and remedial measures are best. A single application of any solution will seldom suffice; hence the crop should be treated again when the effect of the previous treatment is diminished.

Preventives

Plowing of the infested fields as soon as the crop is removed will materially lessen next year's brood. The soil should be turned to a depth of four inches or more.

Destruction of Stumps.—The old stumps in the field or the refuse root crop in the soil should be destroyed. Such materials furnish ideal conditions for the development of this pest.

Rotation of Crops.—Where conditions will permit, rotate the crops so that plants of the family Cruciferae occupy the same soil but a single season. The flies are weak fliers and do not as a usual thing travel far to their hosts.

Screening Seed Beds.—Cabbage plants yet in the seed beds are often infested with this pest, and the maggots are carried with the plants when they are transferred to the field. Mr. Schoene* has studied the value of screening cabbage seed beds and the following discussion is based on his bulletin on this subject. For early settings of cabbage, where the product usually brings a fancy price on the market, screening the seed beds pays very well and appears practical, in fact, whenever the crop is valuable. From the fragmentary data at hand, it appears that the period of the seedling growth checks up very closely with the time when the early emerging adults of the cabbage maggot commence their egg deposition.

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* Schoene, W. J., New York Agricultural Experiment Station, 1911, Bulletin 334.

The usual method is to construct about the bed a frame of six to ten-inch boards placed on edge, well supported and braced, and with cross wires extending over the top to hold up the cloth. Over this frame is stretched cheesecloth, preferably a grade of about 20 threads to the inch. These frames may be used for several years. The following facts are established concerning their use for cabbage seed beds.

1. If the cheesecloth is carefully attached and the frame is tight, injuries by the maggot may be entirely prevented.
2. The work of the flea beetles can be prevented partially or wholly, depending on the grade of cheesecloth employed.
3. The screen conserves the moisture and prevents baking of the soil between seeding time and that period when plants may be cultivated.
4. Plants raised under cloth grow faster during moist seasons and attain the size desirable for transplanting about ten days or two weeks sooner than plants grown in the open.
5. The extra cost of screening plants ranges from six to 20 cents per 1,000. In the opinion of many this cost is met in the first saving of seed.
6. The screened plants are more tender than those not screened, but if the cover is removed a week before transplanting the seedlings will become sufficiently hardened.

The seed bed should by all means be located on a fertile, well drained soil where there can be no accumulation of water or washing under the frames by rain. As it is considerable work to remove the frame to cultivate, see to it that the soil is in good condition and free from weed seed.

Hand Picking.—While a laborious undertaking, is often employed on small fields of cabbage. The plants are simply pulled up, the roots examined carefully for eggs or maggots, and the plant reset. This practice may often be employed to advantage when seedlings are transferred to the field. This method is not practical for radishes or turnips.

The Tarred Felt Discs.—The tarred felt discs are used for the protection of cabbage and cauliflower only, the idea here being to prevent the adult female fly from depositing eggs. No better description of the discs or their use can be given than is found in the original description by W. H. Goff, who perfected this treatment in 1898. The description is transcribed from Circular 63 of the Bureau of Entomology.

The cards are cut in a hexagonal form in order to better economize the material and a thinner grade of tarred paper than the ordinary roofing felt is used, as it is not only cheaper, but being more flexible, the cards made from it are more readily placed about the plant without being torn.

The blade of the tool, which should be made by an expert blacksmith, is formed from a band of steel, bent in the form of a half hexagon, and then taking an acute angle, reaches nearly to the center. The part making the star-shaped cut is formed from a separate piece of steel, so attached to the handle as to make a close joint with the blade. The latter is beveled from the outside all around, so that by removing the part making the star-shaped cut, the edge may be ground on a grindstone. It is important that the angles in the blade be made perfect, and that its outline represents an exact half hexagon.

To use the tool, place the tarred paper on the end of a section of a log or piece of timber and first cut the lower edge into notches, using only one angle of the tool. Then commence at the left side, and place the blade as indicated by the dotted lines, and strike at the end of the handle with a light mallet and a complete card is made. Continue in this manner across the paper. The first cut of every alternate course will make an imperfect card, and the last cut in any course may be imperfect, but the other cuts will make perfect cards if the tool is correctly made and properly used.

The cards should be placed about the plants at the time of transplanting. To place the card bend it slightly to open the slit, then slip it on the center, the stem entering the slit, after which spread the card out flat and press the points

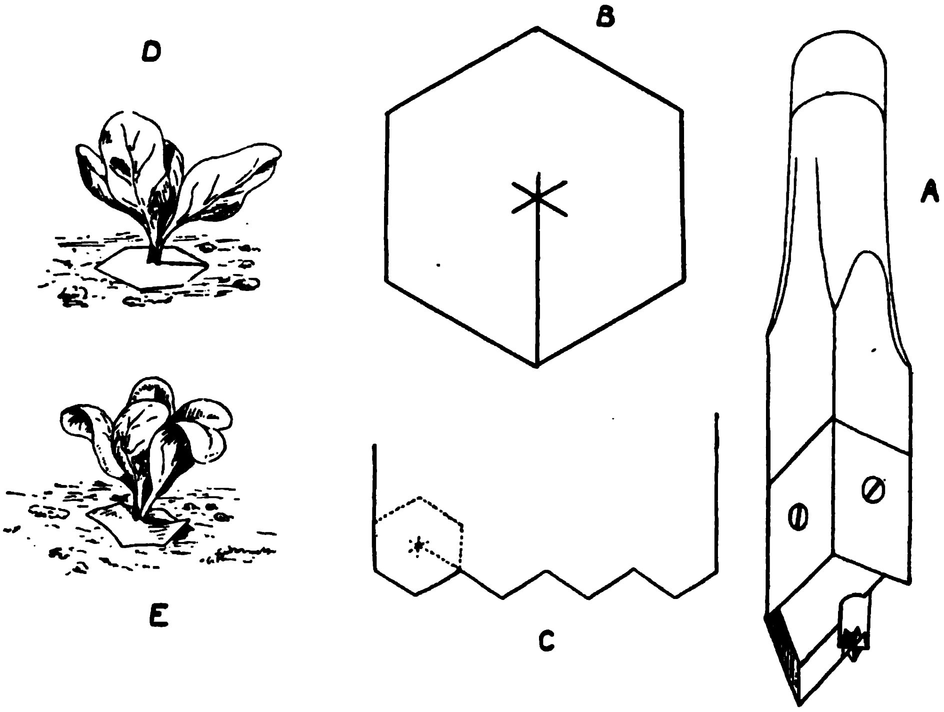

Fig. 5. Tarred Paper Disc and Tool for Cutting.

formed by the star-shaped cut snugly around the stem.

A Wisconsin grower protected 7,000 plants and secured a splendid crop, while unprotected plants nearby would have been a complete failure if the maggots had not been picked off by hand. Others have reported similar success. One reported having lost only 25 plants out of 10,000 to 15,000 that he protected with the cards, where ordinarily he should have lost from 75 to 90 per cent of the crop.

This method in actual practice has proved to be cheap, practical and efficient. Its success depends on the timely and proper application of the cards. They should be applied as soon after transplanting as convenient and must be pressed down firmly about the plant, leaving no open spaces. Soil should not be allowed to collect on top of the disc.

Remedial

In reviewing the current economic literature as well as in local practice, as revealed by our correspondence, I find the results attending the use of the materials for the control of this pest are as varied as the materials themselves. That many of the treatments recommended are impractical is certain. Of those remaining none now in current use seem to give uniform satisfaction under all conditions.

The Carbolic Acid Emulsion.—While giving negative results in our trials, had earlier in the season been suggested to growers, who in several cases commented upon its use most favorably. It is possible the solution was too strong; certainly more trials are necessary to prove the status of this remedy for our conditions. It is prepared as follows:

Crude carbolic acid	1 pint
Hard soap	1 pound
Water	1 gallon

Dissolve the soap in the boiling water; remove from the fire and add the carbolic acid. Agitate briskly for some time to form a perfect emulsion. For application use one part of the emulsion to 30 parts of water.

In using this solution draw back the soil from about the plant, exposing as much root surface as practical. Apply about half pint of the material to each plant. If a pump is used and the solution applied with considerable force, it will require less material and do more good than when simply poured about the plant. This solution should be applied to the plants as soon as they are well established in the field and the application repeated about every eight or ten days.

Kerosene and Sand.—This mixture is made by adding one pint of kerosene to a bucketful of sand, mixing thoroughly. A handful of this substance is placed about each plant as soon as it is well established.

Powdered Tobacco. — This material should be placed about the plant as soon as it is set and the application renewed every week.

Bran and Glue.—This mixture consists of two pounds of glue dissolved in a gallon of water and the addition of sufficient bran to make a thin slop. A handful of this is then placed about each plant. This material, in certain cases, has given very satisfactory results.

Hellebore Decoction.—This solution is prepared by steeping two ounces of powdered hellebore in a quart of water for one-half hour. Dilute to make one gallon of solution. Apply in the same manner as the carbolic acid emulsion solution.

Literature

1894—Slingerland, M. V. (Cornell Uni. Exp. Sta. Bull. 78.)

1906—Chittenden, F. H. (U. S. Dept. Agri., Bur. Ent. Cir. 63.)

1906—Washburn, F. L. (Minn. Agri. Exp. Sta. Bull. 100.)

1907—Smith, J. B., and Dickerson, E. L. (N. J. Exp. Agri. Sta. Bull. 200.)

1908—Schoene, W. J. (N. Y. Agri. Exp. Sta. Bull. 301.)

1909—Smith, J. B. (N. J. Agri. Exp. Sta. Ann. Rept., 1909.)

1911—Schoene, W. J. (N. Y. Agri. Exp. Sta. Bull. 334.)

1911—Schoene, W. J. (Jour. Eco. Ent. IV, 2, p. 210.)

Common Cabbage Looper

Autographa brassicae

The larva is a green worm, lined with white about one and a quarter inch long when grown. Has the looping habit like the span worm. Eats the leaves full of holes.

Spraying with salt water is useful.

Treat same as for imported cabbage worm.

Cross-Striped Cabbage Worm

Pionea rimosalis Guen

The moth is pale yellow in color and lays its eggs in masses of 20-40 on the under side of leaves, the eggs overlapping each other like fish scales. The young larva is gray in color with a large head. When full grown it is bluish gray with conspicuous black stripes crosswise of the body.

Distributed from the South Atlantic states westward to Nebraska.

The worms do considerable damage at times. Poison bran mash is a standard remedy. Mix bran with water and sugar before adding the Paris green. Three ounces of sugar to enough bran to make a mixture that will run through the fingers when mixed in a gallon of water.

Cooperation in clean farming is a good preventive. Gather and destroy all refuse from the cabbage fields.

Cutworms

Noctuidae

A. L. Lovett

Cutworms are a very serious pest of nearly all our crops. Ornamental shrubs, garden and truck crops, field crops and even small fruits and orchards suffer from the attack of these pests. The sleek, well fed, greasy caterpillars, varying in size, when mature, from one to two inches, are too well known to require a description. The adult moths are nocturnal in habit, flying mostly at night.

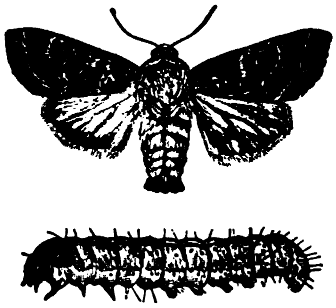

Fig. 1. Glassy Cutworm Adult and Larva. (Exp. Farms Repts. 1910.)

The majority of the medium sized, smoky grey and brownish moths, which are attracted to the lights, are adults of the cutworm caterpillars.

Remedies

The poison bran mash, consisting of bran 16 pounds, Paris green one pound, salt one-half pound, cheap syrup one gallon, and warm water to make a coarse mash, is the standard remedy for cutworms. This may be placed on a field prepared for a crop or may be placed about the base of the plants when they appear. Poultry should not be allowed free range over a treated field. Green succulent forage of any kind may be sprayed with an arsenical, mowed and placed in small heaps about the field, preferably in the evening. Where these methods are impracticable, arsenical sprays applied to the host are of some assistance. For young plants just set in the field, as cabbage and tomato, a mechanical barrier consisting of a cylinder of tin or cardboard may be shoved down about the plant.

For the climbing cutworms, which attack the developing buds of our fruit trees in early spring, the poison baits are very good; but better still, is a belt of some sticky material about the trunk of the tree, or some mechanical device such as a piece of cardboard attached funnel shaped, tight at the top and flared below. Cotton batten may be used in a similar manner. Wrap a strip eight inches wide about the tree overlapping it at the edges where it meets. Tie this band at the lower edge, then, taking hold of the upper edge, roll it down over the bottom edge. This makes a very effective funnel.

Diamond-Back Moth
Plutella maculipennis

The larva is a very small green worm. The moth is about one-third inch long and folds its wings roof-like over its body. A white line borders the inside of each fore wing and these coalesce to form a single white stripe down the back with diamond-shaped expansions at intervals when the wings are folded.

Larvae usually feed on lower surface of leaves and not until quite numerous do they eat holes clear through.

Treat the same as for imported cabbage worm.

A. D. SELBY

Dipterous Leaf Miners

There are several species, notably the imported turnip leaf miner, native cabbage leaf miner, imported cabbage leaf miner, native clover leaf miner.

They are minute flies which lay their eggs in the cabbage and other plant leaves, the young larvae ruining the leaf. Not very injurious and no practical remedy is known.

Flea Beetles
Several Species

Minute beetles that jump like fleas when disturbed.

They eat small holes in the leaves of the plant, or if numerous, destroy whole sections of the leaf.

Spray with Bordeaux mixture.

Harlequin Cabbage Bug
Murgantia histrionica Hahn
Family Pentatomidae

General Appearance

The adult bugs are black with bright red markings. They are one half inch long and two-thirds as wide. The eggs are almost imitations of miniature white barrels with black hoops and black spots in the proper places for bungholes. They are arranged in clusters side by side. The young greatly resemble the adults, but lack wings and yellow predominates. This color gradually changes to orange and red as the nymphs reach maturity.

Life History

The adults hibernate in various sheltered places over winter and appear with the first warm weather in the spring to feed. The first plants to furnish food are wild mustard, radish and other members of the cruciferous weeds. Upon these also the eggs are laid and the young soon appear in great numbers in time to migrate to the cabbage plants and work upon them throughout the summer. Successive broods may appear in the

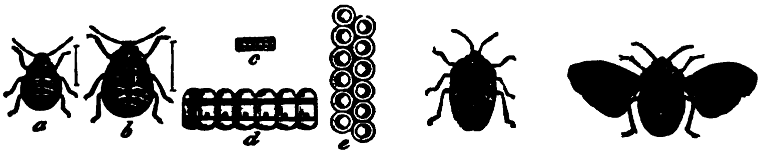

Fig. 1. The Cabbage Bug, *Murgantia histrionica* (Hahn.). *a* and *b*, young; *c*, *d* and *e*, eggs; adults at right. —*After Riley*

cabbage fields and the numbers so increase as to cause much damage. In the southern part of the state the adults continue active throughout the winter.

Food Plants

This bug is especially fond of all cruciferous plants, including mustard, radish, cabbage, cauliflower, turnips, rape, horseradish, etc. Other food plants are potatoes, eggplant, okra, beans, beets, roses, sunflowers, chrysanthemums, squash, ragweed, pigweed, wild lettuce, lambsquarters and most of the plants belonging to the caper family. Occasionally nursery trees, citrus, locust, cherry, and plum are injured, and the fruit of the grape and corn ears also suffer.

Control

Methods recommended for the squash bug are also applicable to the control of the cabbage bug. Planting an early crop of cabbage, rape, mustard or radish is especially recommended. The eggs are laid in great numbers upon these plants and together with the adults may be destroyed. This practice greatly lessens subsequent attacks.

See under *Squash*.

Natural Enemies

Great numbers of the eggs are destroyed by two small internal parasites, *Trissolcus murgantiae* Ashm. and *Ooencyrtus johnsoni* How. The wheel bug, *Arilus cristatus* Linn., feeds upon the young nymphs in the Eastern states.

E. O. Essig

Hop Flea Beetle

Psylliodes punctulata Melsh

Family Chrysomelidae

General Appearance

A very small, black metallic beetle with greenish tinge; oval in form; one tenth of an inch long and half as wide. The eggs are very small, oval in shape and yellow. The larvae are small white grubs about 5 mm. long. The white pupae as well as the larvae are found in the soil.

Life History

The adults appear early in the spring and are ready to attack the first hop plants as soon as they come through the ground. They feed upon the upper surfaces of the leaves, completely skeletonizing them. The vines are attacked when young and are often completely destroyed before they have reached a height of three or four feet. When disturbed the beetles hop or fall to the ground. They are able to make their way through the soil without much difficulty and lay their eggs upon the roots of the food plants.

The larvae are very small and white in color with dusky markings. They live in the ground feeding upon the roots of various plants. When full grown they pupate in the soil from which the adults emerge throughout nearly the entire year, the largest number appearing from early spring to August. There are probably two generations a year.

Food Plants

This species feeds upon hops, cabbage, potatoes, beets, turnips, dock, lambsquarters, pigweed, clover, rhubarb, cucumber, radish, mustard and nettle.

Control

There have been numerous methods of control recommended for this pest. The measures directed against the hibernating beetles consist in killing all on the poles or burning up the rubbish. In the spring the first step consists in capturing the adult beetles on the young vines. A tarred board or hand hopper dozer is used on or into which the beetles are shaken. Tanglefoot bands around the bases of the tresseled vines, as well as around the poles, not only keep the beetles from the foliage but capture great quantities of them. Various contract sprays, such as tobacco extract, emulsions, soaps, resin wash, and arsenic also have been used with good effect, but the cost due to great numbers of applications necessary, makes them almost prohibitive.

E. O. ESSIG

Imported Cabbage Web Worm

Hellula undalis, Fab

The moth is gray in color with mottled fore wings which have an expanse of about five-eighths of an inch. The full-grown larvae are about half an inch long, grayish-yellow with five longitudinal bands.

Distributed pretty well over the South and Southeast. Does considerable damage to cabbages, turnips, beets and the cruciferae generally.

Several species of flies are parasites.

Bordeaux mixture sprayed on the plants when first set out acts as a repellent. Clean culture and destruction of refuse material is also suggested.

Literature

Bureau Entomology Bulletin 109, Pt. III.

Division Entomology Bulletin 33, New Series.

Imported Cabbage Worm

Pontia rapae Sch.
Family Pieridae
Pieris rapae Linn.

General Appearance

Though this is an imported insect it has become as common as if it had always been here. The adult butterflies are about one and one-fourth inches long with a wing expanse of two inches. The color is white with two small black spots near the middle and a large black spot at the tip of each fore wing. The caterpillars are light velvety green in color and very finely dotted with minute dark spots. The length when full grown varies from one to one and one half inches. The chrysalis is about one inch long and varies in color from yellow to green, light or dark gray.

Life History

In the northern part of the state the species winters over in the chrysalis stage, while in the south adult butterflies may be seen almost any time of the year. They become very much in evidence early in March and are active throughout the entire summer and fall. Egg laying begins soon after the adults leave the chrysalis stage. The eggs hatch in about a week and the young caterpillars begin feeding at once. They first feed upon the outer leaves, making them ragged and holey, but gradually work through towards the heart of the cabbage, leaving the dark-green excrement to mark their paths of destruction. The growth is very rapid so that in from one to two weeks they are ready to select some secluded spot beneath an old cabbage leaf or some nearby object and prepare for the chrysalis stage, which, during the first two generations in the summer months, lasts little longer than the larval stage, but which in the fall continues throughout the winter. There are several generations a year. In fact in the southern part of the state it seems as if the breeding is only slightly checked during the winter months.

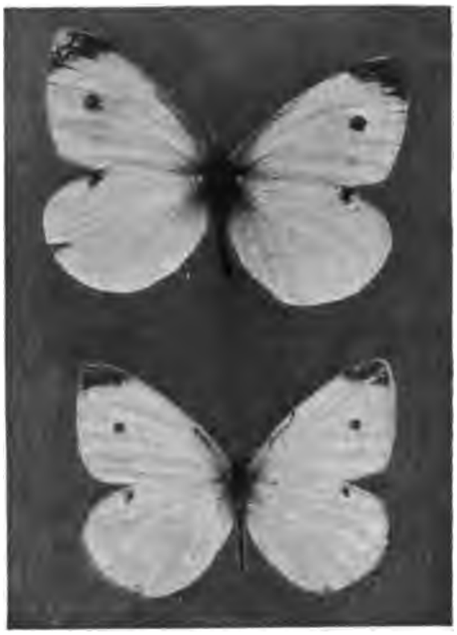

Fig. 1. Adults, Imported Cabbage Worm. (Tennessee Experiment Station)

Food Plants

The principal economic food plants are cabbage, cauliflower, brussels sprouts, turnip, radish, mustard, and horseradish. Other plants attacked are wild mustard, wild radish, nasturtium, mignonette and sweet alyssum.

Control

The larvae, working as they do into the heads of the cabbages, make control methods practically impossible after they have once begun. Young plants may well be protected by arsenical sprays which are applied with safety until the heads are half grown. Prof. L. Bruner claims that cornmeal dusted on the cabbages causes the worms to leave. Clean culture should be practiced and no cabbage or host plants allowed to grow during the interval between crops unless they are freely sprayed with strong solutions of arsenical sprays.

Natural Enemies

Internal parasites, working upon the chrysalids, are important factors in the control of the pest. In this state the small parasite *(Pteromalus puparum)* is quite widely distributed and is bred and sent to all parts of the state by the State Insectary. In the Eastern states a chalcid *(Apanteles glomeratus)* does excellent work in killing off the caterpillars, but this has not been established in this state. A bug *(Phymata wolffii)* preys upon the butterflies, which they capture on flowers while the wasp *(Polistes pallipes)* destroys large numbers of the worms.

E. O. Essig

(Further remedies suggested by A. L. Lovett, of Oregon Experiment Station.—Ed.)

For very small plants use Paris green one pound, and air slaked lime, road dust or cheap flour 20 pounds. Mix thoroughly and dust over plants by sifting through a coarse sack. This material will adhere better if applied in the early morning while the dew is on.

For older plants the regular arsenical sprays may be used, adding a little soap to aid them in sticking, or better still, use the resin lime mixture prepared as follows:

Stock solution:

Pulverized resin	5 pounds
Concentrated lye	1 pound
Fish oil soap or any cheap animal oil, except tallow	1 pint
Water	5 gallons

Place the oil, resin and one gallon of hot water in vessel for cooking. Heat until the resin is softened, add the lye solution made as for hard soap, stir thoroughly and add four gallons more of hot water. Boil for two hours or until the mixture will unite readily with water, making a clear amber liquid. Add water to make up for that lost by evaporation. This constitutes the stock solution and may be kept indefinitely. In applying it, for every gallon of the stock solution add first 16 gallons of water, then three gallons of thin whitewash and one-quarter pound of Paris green.

Hot water at a temperature of 130 Fahrenheit will kill the worms and will not injure the cabbage plants.

Native Cabbage Worm

Pontia protodice. Pieris protodice

Butterfly, looks much like the last, but has about four angular black marks at and behind tips. Female very different from male, with wings all checkered with black.

Worm, obscure, purple color, with four longitudinal pale yellow stripes, two on each side. Head and body minutely dotted with black. Pupa, in the main, like the last, but dotted with black. The worm, though not nearly so troublesome as the imported, can be overcome by the same sprays.

L. F. Henderson

Seed-stalk Weevil

Ceutorhynchus quadridens Panz

A somewhat serious pest in sections where seed cabbages are grown, as in Long Island. No remedy suggested.

Western Twelve-Spotted Cucumber Beetles. See under *Cucumber*.

Literature

Bulletins of the State Experiment Stations and the United States Department of Agriculture, mostly of the last two decades:

Common Cabbage Looper

Autographa (Plusia) brassicae Riley

1884. The cabbage plusia.—C. V. Riley (U. S. D. A. Rpt., 1883, pp. 119-122, pls. 2).
1893. A few common insect pests.—C. P. Gillette (Colo. Bul. 24, pp. 8, 9, fig. 1).

1898. A spraying mixture for cauliflower and cabbage worms.—F. A. Sirrine (N. Y. State Bul. 144, pp. 38-46, pl. 1).

1902. Some insects injurious to vegetable crops.—F. H. Chittenden (U. S. D. A., Bur. Ent. Bul. 33, pp. 60-69, figs. 2).

1909. Some cabbage worms and suggestions for destroying them.—W. E. Rumsey and Fred E. Brooks (W. Va. Bul. 120, pp. 345-352, pls. 2).

Diamond-back Moth

Plutella maculipennis (cruciferarum) Curtis

1892. Insects injurious to the cabbage. —H. E. Weed (Miss. Bul. 21, pp. 8, 9, fig. 1).

1893. Injurious insects of Maryland.—C. V. Riley (Md. Bul. 23, pp. 83, 84, fig. 1).

1895. The pests of the orchard and garden.—L. R. Taft and G. C. Davis (Mich. Bul. 121, p. 62, fig. 1).

Imported Cabbage Worms

Pontia (Pieris) rapae Linn

1889. Important injurious insects.—C. P. Gillette (Ia. Bul. 5, pp. 171-174, fig. 5).

1894. Insects affecting late cabbage.—F. A. Sirrine (N. Y. State Bul. 83, pp. 658-666, pl. 1).

1895. Treatment of common diseases and insects injurious to fruits and vegetables.—S. A. Beach and W. Paddock (N. Y. State Bul. 86, pp. 98, 99).

1895. Insects injurious to fruits and vegetables.—J. T. Stinson (Ark. Bul. 33, pp. 81, 82, figs. 2).

1905. The imported cabbage worm.—F. H. Chittenden (U. S. D. A. Bur. Ent. Circ. 60, pp. 8, fig. 6).

1907. Imported cabbage butterfly (N. Y. State [Geneva] Rept. 25, Pt. 3, pp. 243-245, pl. 1).

Southern Cabbage Butterfly

Pontia (Pieris) protodice Boisd.

Potherb Butterfly

Pontia (Pieris) napi Linn

Cross-striped Cabbage Worm

Evergestis (Pionea) rimosalis Guen

Cutworms

Various species of Noctuids

1895. Cabbage cut worms.—C. V. Riley (U. S. D. A. Rpt. 1884, pp. 289-300, figs. 10) Describes the following:

Dark-sided cutworm, *Agrotis messoria* Harr.

Granulated cutworm, *Agrotis annexa* Treitschke.

Shagreened cutworm, *Agrotis malefida* Guen.

W-marked cutworm, *Agrotis clandestina* Harr.

Greasy cutworm, *Agrotis ypsilon* Rott.

Speckled cutworm, *Mamestra subjuncta* G. & R.

Glassy cutworm, *Hadena devastatrix*, Brace.

Variegated cutworm, *Agrotis saucia* Treitschke.

1895. Cutworms, etc.—J. B. Smith (N. J. Bul. 109, pp. 3-13, figs. 3).

1895. Cutworms in Kentucky.—H. Garman (Ky. Bul. 58, pp. 89-107, pl. 1).

1895. Climbing cutworms in Western New York.—M. V. Slingerland (N. Y. Cornell Bul. 104, pp. 553-600, pls. 5, figs. 2).

1895. Insects injurious in 1895.—O. Lugger (Minn. Bul. 43, pp. 232-243, fig. 1).

1896. Some injurious insects.—G. C. Davis (Mich. Bul. 132, pp. 3-14, figs. 8).

1907. Cutworms. — H. T. Fernald (Mass. Circ. 2, pp. 2).

Imported Cabbage Webworm

Hellula undalis Fab.

1899. Some insects injurious to garden and orchard crops.—F. H. Chittenden (U. S. D. A., Bur. Ent. Bul. 19, pp. 51-57, fig. 1).

1900. Some insects injurious to garden crops.—F. H. Chittenden (U. S. D. A., Bur. Ent. Bul. 23, pp. 53-61, fig. 1).

Cabbage Aphis

Aphis brassicae Linn

1890. Plant lice and how to deal with them.—J. B. Smith (N. J. Bul. 72, pp. 16-20, figs. 2).

1892. Horticulture and entomology.—E. S. Richman (Utah Bul. 14, pp. 7-10, figs. 7).

1893. Miscellaneous entomological papers.—F. M. Webster (Ohio Bul. 51, pp. 109-111).

1897. Some common injurious plant lice, with suggestions for their destruction.—W. G. Johnson (Md. Bul. 48, pp. 97, 98, fig. 1).

1909. Some insects injurious to cabbage, cucumbers and related crops.—F. H. Chittenden (Va. Truck Sta. Bul. 2, pp. 22-30, figs. 4).

Cabbage Root Maggot

Pegomya (Phorbia) brassicae Bouche

1894. The cabbage root maggot, with notes on the onion maggot and allied insects.—M. V. Slingerland (N. Y. Cornell Bul. 78, pp. 481-577, figs. 18).

1905. Root maggots and how to control them.—F. H. Chittenden (U. S. D. A., Bur. Ent. Circ. 63, pp. 7, figs. 5).

1905. Cabbage root maggot. Poisoned bran for cutworms.—W. S. Blair (Canada Exp. Farms Rpt. 1904, pp. 362-364).

1906. The cabbage maggot and other injurious insects of 1906.—F. L. Washburn (Minn. Bul. 100, pp. 1-19, cld. pl. 1, figs. 11).

1907. The cabbage and onion maggots.—John B. Smith and E. L. Dickerson (N. J. Exp. Sta. Bul. 200, pp. 27, figs. 13).

1907. The cabbage maggot and other injurious insects of 1906.—F. L. Washburn (Minn. Bul. 100, pp. 87, pls. 7, figs. 57).

1907. Root maggots.—H. T. Fernald (Mass. Circ. 5, pp. 2).

1908. The apple leaf hopper and other injurious insects of 1907 and 1908.—F. L. Washburn (Minn. Bul. 112, pp. 196-213, figs. 3).

1908. Screening for the protection of cabbage seedbeds.—W. J. Schoene (N. Y. State Bul. 301, pp. 165-174, pl. 1).

Cabbage Flea Beetle, or Striped Turnip Flea Beetle

Phyllotreta vittata Fab.

1885. The wavy-striped flea beetle.—C. V. Riley (U. S. D. A. Rpt. 1884, pp. 301-304, fig. 1).

1890. The cabbage flea beetle.—H. Garman (Ky.) Rpt. 1889, pp. 23-25).

1891. The striped flea beetle or cabbage flea.—A. D. Hopkins (W. Va. Rpt. 1890, pp. 147-150).

1895. Remedies for flea beetles.—C. M. Weed (N. H. Bul. 29, pp. 3-7, figs. 5).

Harlequin Cabbage Bug

Murgantia histionica Hahn

1908. The harlequin cabbage bug.—F. H. Chittenden (U. S. D. A., Bur. Ent. Circ. 103, pp. 10, fig. 1).

False Chinch Bug

Nysius angustatus Uhl

1894. Chinch bugs.—L. Brunner and H. G. Barber (Neb. Bul. 34, pp. 153, 154, fig. 1).

Cabbage Curculio

Coutorhynchus rapae Gyll

1900. Some insects injurious to garden crops.—F. H. Chittenden (U. S. D. A., Bur. Ent. Bul. 23, pp. 39-53, figs. 2).

Cabbage Hair Worm

Mermis spp et al.

1905. Cabbage snakes.—H. Garman (Ky. Bul. 120, pp. 78-81, pl. 1).

1908. The cabbage hair worm.—F. H. Chittenden (U. S. D. A., Bur. Ent. Circ. 62, pp. 6, fig. 1).

Lists of Books and Pamphlets

1901. Bibliography of the more important contributions to American economic entomology. Part VII. — Nathan Banks (U. S. D. A., Bur. Ent., pp. 113). Price, cloth, 20 cents. Postage, 3 cents. (Covers the period between December 31, 1896, and January 1, 1909).

1905. Bibliography, etc. (as above).—Nathan Banks (U. S. D. A., Bur. Ent., pp. 132). Price, 10 cents. Postage, 3 cents. (Covers the period between December 31, 1899, and January 1, 1905).

1910. A list of works on North American entomology—Nathan Banks, (U. S. D. A., Bur. Ent. Bul. 81, pp. 120). Price, 15 cents. Postage, 4 cents.

(Application and money for these bibliographies should be sent to Superintendent of Documents, Government Printing Office, Washington, D. C.)

Useful works on economic entomology, containing information on the pests of cole crops.

1902. Insects injurious to staple crops.—E. D. Sanderson (New York; John Wiley & Sons, pp. 205, figs. 162). Price, $1.50.

1906. Economic entomology.—J. B. Smith (Philadelphia: J. B. Lippincott Co., pp. 475, figs. 475). Price, $2.50.

1907. Insects injurious to vegetables.—F. H. Chittenden (New York: Orange Judd Co., pp. 262, figs. 163). Price, $1.50.

Bulletins covering in a general manner the treatment of cabbage insects.

1904. Cabbage diseases and insects.—J. B. S. Norton and T. B. Symons (Md. Circ. Bul. 58, pp. 10, figs. 6).

1904. Insects injurious to cabbage.—H. Garman (Ky. Bul. 114, pp. 15-47, figs. 17).

1906. Cabbages for stock feeding.—S. Fraser (N. Y. Cornell Bul. 242, pp. 69, 70).

1906. Farm practice in the control of field-crop insects.—F. M. Webster (U. S. D. A. Yearbook 1905, pp. 465-476, pls. 2, figs. 2). (Published separately as Yearbook Separate 396.)

California

California grows more fruit than any other state in the Union. It is not as large as Texas but its coast line on the west, its high mountain ranges on the east and west extending from north to south through the whole length of the state, and its great central plain, the climate of which is modified by the ocean breezes cooling the temperature in summer and modifying its severity in the winter, make it better adapted to all kinds of fruits, from the semi-tropical to the hardier fruits grown generally in the northern climates, than any other portion of the United States. It has a great variety of soils, as well as of climate. Sometimes within a few miles of each other, two different points, on account of altitude, wind currents, ocean breezes, or difference in soils, may be adapted to the growing of fruits that are generally found at great distances from each other, in other parts of the United States. California grows fewer apples than New York, Pennsylvania or Missouri, and a number of other states, but not far from the apple-growing region may be found oranges, lemons, and other semi-tropical fruits. These fruits have produced immense wealth and have enabled the inhabitants to make beautiful homes, while at the same time there are regions that partake largely of the nature of the arid districts of other states. It has a coast line of 900 miles.

Granville Lowther

Harvest Time for Various Crops in California

The following table shows the time at which some of the various fruits, vegetables, and garden products are harvested:

Almonds	August to September
Apples	July to November
Apricots	June to August
Blackberries	June to September
Cantaloupes	May to July
Cherries	May to July
Currants	May to June
Dewberries	May to July
Figs	July to November
Grapes	July to January
Grape Fruit	All the year
Guavas	All the year (two crops)
Lemons	All the year
Limes	All the year
Loganberries	June to September
Loquats	May and June
Mulberries	July to September
Nectarines	June to August
Olives	October to January
Oranges	October to January
Pears	July to November
Peaches	July to Christmas
Persimmons, Japanese	November and December
Plums	June to September
Prunes	June to September
Pomegranates	September to December
Quinces	October to December
Raspberries	June to October
Strawberries	All the year
Watermelons	July to October

Vegetables

Asparagus	March to July
Beans	May to October
Cabbage	All the year
Cauliflower	October to June
Celery	October to June
Corn	May to October
Cucumbers	April to November
Lettuce	All the year
Melons	May to October
Onions	All the year
Peas	All the year
Potatoes	two crops plant August and February
Radishes	All the year

E. J. Wickson

Frost and Precipitation in California

Station	No.	Frost				Precipitation
		Average Date of		Date of		Annual
		First killing Autumn	Last in Spring	Earliest in Autumn	Latest in Spring	inches
Sission	1	Sept. 26	May 26	Sept. 13	July 6	37.8
Cedarville	2	Sept. 27	May 11	Sept. 14	June 2	13.7
Eureka	3	Nov. 15	Apr. 9	Nov. 7	May 1	45.8
Redding	4	Dec. 3	Mar. 23	Nov. 20	May 1	36.2
Susanville	5	Oct. 3	May 10	Sept. 8	May 22	22.9
Red Bluff	6	Nov. 25	Mar. 15	Nov. 7	Apr. 19	25.7
Chico	7	Dec. 14	Mar. 24	Dec. 12	Apr. 10	22.4
La Porte	8	Sept. 15	May 31	Sept. 6	July 6	77.9
Ukiah	9	Nov. 26	Mar. 27	Oct. 16	May 2	35.0
Summit	10	....	....	....	....	46.9
Auburn	11	....	....	....	....	33.4
Davisville	12	Dec. 7	Feb. 26	Nov. 26	Apr. 4	16.6
Sacramento	13	Nov. 15	Feb. 16	Oct. 28	Apr. 26	19.9
Napa	14	Dec. 24	Feb. 27	Nov. 27	Mar. 30	23.7
San Francisco	15	....	Jan. 25	Dec. 13	Apr. 20	22.5
Livermore	16	Dec. 2	Feb. 23	Nov. 9	Apr. 12	15.3
San Jose	17	Dec. 6	Feb. 8	Nov. 28	Feb. 18	14.8
Merced	18	Dec. 11	Mar. 5	Nov. 28	Mar. 28	10.3
Santa Cruz	19	Dec. 7	Mar. 12	Nov. 26	Mar. 30	27.0
Hollister	20	Nov. 23	Mar. 16	Nov. 8	Apr. 27	12.3
Fresno	21	Dec. 15	Mar. 4	Nov. 18	Apr. 14	9.2
Independence	22	Oct. 25	Mar. 17	Sept. 21	May 28	3.7
King City	23	....	....	....	....	10.8
Visalia	24	Nov. 21	Apr. 11	Nov. 16	Apr. 11	9.8
San Luis Obispo	25	Dec. 17	Mar. 17	Nov. 15	Apr. 8	19.2
Bakersfield	26	....	....	....	....	4.8
Santa Barbara	27	....	....	....	....	16.6
Los Angeles	28	....	Apr. 8	Dec. 12	Apr. 8	15.6
Redlands	29	Dec. 12	Feb. 19	Nov. 24	Apr. 29	14.8
Needles	30	....	....	....	....	2.7
Salton	31	....	....	....	....	2.5
San Diego	32	....	....	....	....	9.4

Table of Productiveness

A table of productiveness of various articles that can be raised on one acre of ground in California:

Alfalfa	$ 35	to	$ 60
Almonds	75	to	200
Apples	100	to	200
Apricots	75	to	150
Asparagus	100	to	250
Berries	150	to	500
Blackberries	250	to	500
Beans	30	to	100
Cherries	100	to	225
Chestnuts	150	to	400
Figs	100	to	250
Loganberries	250	to	300
Lemons	100	to	400
Melons	$ 25	to	$125
Nectarines	100	to	200
Olives	75	to	150
Oranges	150	to	800
Peaches	100	to	250
Potatoes (Sweet)	50	to	150
Potatoes (Irish)	50	to	150
Prunes	75	to	200
Pears	100	to	400
Pomelos	100	to	400
Plums	100	to	200
Pecans	150	to	600
Quinces	100	to	200
Raisin Grapes	75	to	150
Strawberries	150	to	300
Table Grapes	100	to	500
Tomatoes	50	to	150
Walnuts	200	to	800

E. J. WICKSON

California Canned Fruits and Vegetable Packs

(Compiled yearly by California Fruit Grower from individual packers' reports.)

FRUIT	1911 Cases		1910 Cases		1909 Cases	
	Nos. 2½ and 3, etc. (all grades)	(No. 8 gallons) (all grades)	Nos. 2½ and 3, etc. (all grades)	(No. 8 gallons) (all grades)	Nos. 2½ and 3, etc. (all grades)	(No. 8 gallons) (all grades)
Apples	8,750	56,550	6,280	70,550	7,375	62,600
Apricots	708,500	149,825	544,530	198,630	563,660	100,450
Blackberries	35,250	42,575	26,425	35,600	22,625	27,330
Cherries, Royal Ann	99,700	11,740	123,240	13,050	110,250	7,450
Cherries, black	26,860	2,005	18,110	1,510	16,700	1,375
Cherries, white	49,730	8,770	33,410	5,875	51,640	4,520
Grapes	62,115	8,800	39,285	6,360	20,105	4,365
Loganberries	12,106	7,011	6,977	5,662	3,204	808
Nectarines	5	18	....	1	....	14
Pears	579,960	38,960	568,125	51,230	466,530	34,910
Peaches, free	582,200	156,200	553,000	195,825	401,800	145,375
Peaches, cling	1,210,525	142,200	1,233,200	163,425	779,725	109,260
Plums	143,350	22,490	65,550	14,810	75,450	13,975
Raspberries	2,950	675	9,335	791	3,375	215
Strawberries	6,505	1,210	13,225	848	9,690	890
Other fruits	1,390	3,725	2,250	1,440	700	635
Total fruits (cases)	3,529,896	652,754	3,242,942	765,607	2,532,829	514,172
Grand total fruits	4,182,650		4,008,549		3,047,001	
VEGETABLES						
Asparagus	684,960	2,105	614,050	3,225	410,335	630
Beans	53,110	12,710	41,610	4,640	10,490	1,945
Peas	162,570	22,205	140,855	26,920	88,360	15,650
Tomatoes	1,306,190	209,260	1,159,875	190,435	567,300	104,960
Other vegetables	39,575	23,970	49,075	19,960	38,350	4,700
Total vegetables (cases)	2,246,405	270,250	2,005,465	245,180	1,114,835	127,885
Grand total vegetables	2,516,655		2,250,645		1,242,720	
Grand total pack (cases)	6,699,305		6,259,194		4,289,721	

—From Annual Review Number 1912 California Fruit Grower, page 17.

THE CALIFORNIA CITRUS INDUSTRY

Growing of citrus fruits in California is rapidly advancing in acreage and in product, each year receiving greater investment and effort, and each year reaching a greater aggregate gross return for the product marketed. There has also been gratifying progress made in meeting the problems and difficulties which are bound to arise in the development of an industry involving so many novel situations and affecting so many interests—individual, corporate, and political. In the following brief statement I shall endeavor to indicate what seem to me the most salient features of the California citrus industry, chiefly from the commercial point of view.

California Citrus Census

The report of the California State Board of Equalization, which presents the figures gathered by the assessors in all the counties of the state, shows that there were growing in the spring of 1912 the following totals of citrus trees in California, viz.:

	No. of trees Bearing	No. of trees Non-Bearing
Lemon	952,290	743,352
Lime	1,371	450
Orange	6,013,272	633,366
Pomelo	11,321	6,280
Totals	6,978,254	1,383,448

These figures show the leadership of the orange, the rather remote second of the lemon, and the fact that the two show about the same rate of increase through recent plantings. They also indicate a greater rate of increase in the pomelo, though the total is still insignificant, and that the lime is only a curiosity. Other citrus fruits are too small in number for enumeration.

Taking the orange and lemon as a measure of the citrus geography of California, and choosing counties having more than 100,000 trees, bearing and non-bearing, according to the 1912 report of the California State Horticultural Commissioner, the following statement results:

Counties	Number of Orange trees	Number of Lemon trees
San Bernardino.....	3,720,320	385,490
Los Angeles........	2,431,000	852,500
Riverside	1,934,790	392,676
Tulare	3,412,000*	......
Orange	929,480	237,405
Ventura	204,961	298,176
Butte	192,168	3,032
Fresno	170,000	5,200
San Diego..........	101,017	295,957
Santa Barbara......	599	297,386

These counties are distributed through a north and south distance of about 550 miles, and the interest is concentrated toward the south and widely scattered toward the north, with much intervening land as good for citrus fruits as that already planted. Citrus fruits are equally safe throughout the whole distance, and it is clear that California has a capacity for citrus production far beyond present attainment, if greater amounts of fruit can be profitably sold, as it certainly promises to be, if current protection is maintained.

Mr. G. Harold Powell, Secretary of the Citrus Protective League of California, estimates that California citrus plantings now occupy about 150,000 acres of land and represent in lands, trees, buildings and operating property of all kinds a value of $200,000,000. He also estimates the fruit produced at almost $40,000,000, valued at selling points. The annual shipments for several years have been as follows: 1908-9, 40,516 carloads; 1909-10, 33,099 carloads; 1910-11, 46,394 carloads and 1911-12, 40,290 carloads.

California Citrus Problems

Cultural problems connected with growing citrus fruits are many. Some of them have evidently reached a basis of settlement. For instance, nearly all insects are controlled by fumigation, and the remaining requirements are to do the work more effectively and economically. The problems of the development of irrigation water from streams or from underground sources and the distribution thereof have been well worked out, but the ministration of water to the tree so that its greatest vigor and producing efficiency shall be maintained is not yet satisfactorily mastered. The desirability of soil improvement, chemically and physically, by the growing and covering-in of legumes in the orchard has been fully demonstrated, but choice of particular plants and cultural policies are still to be determined. The use of fertilizers is constantly increasing and their indispensability recognized, but their relations to tillage, moisture distribution, and to the vegetative functions of the trees are still matters of conflicting opinions.

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* Orange and lemon trees together.

The Citrus Protective League

And yet the problems which California citrus growers wrestle with most successfully are commercial problems, and they have created unique organizations to labor for their solution. Mr. G. Harold Powell, then secretary and manager of the Citrus Protective League, in January, 1911, issued a general statement of the character and work of the organization from which the following generally significant paragraphs are taken:

The Citrus Protective League of California is a voluntary organization formed in March, 1906, by representatives of growers, shippers and shipping organizations in nearly all of the citrus growing localities in the state, to handle the public policy questions that affect the industry as a whole. Its purpose is to represent the grower and shipper in handling such questions as railroad rates and transportation problems; customs tariffs and other governmental relations, state and federal legislation that applies directly to the business; and all other questions of a general nature that affect the upbuilding of the industry, except the marketing of fruit.

The league is directed by an executive committee of nine and by a secretary and manager, the executive committee having been appointed by an administrative committee of 30 of the principal growers and shippers, who act as a governing committee, and who were selected from the representative delegates who organized the league in 1906.

The league is supported by funds raised by general assessment, based on the number of cars of fruit shipped by each member during the preceding year. Fourteen assessments were levied to December 31, 1910, and $68,654.88 has been paid in by the members in the five years since the league was organized, of which approximately $65,000 was expended in the management of its business to December 31, 1910.

The league has played an important part in the progress of the citrus industry in the past five years.

In 1907 it induced the railroads to reduce freight rates on oranges 10 cents per 100 pounds, from $1.25 to $1.15. This rate became effective February 26, 1907, since when it has saved the shippers from $28 to $30 per car. The gain to the industry from February 26, 1907, to December 31, 1910, from this reduction has been about $3,175,000, or about 45 times the entire cost of the league, from the date of organization to the present time.

Following the reduction in the freight rate and as a result of the succeeding agitation accompanying the refrigeration rate question, the railroads changed the refrigeration tariffs, allowing 32,000 pounds of fruit to be shipped in a 40-foot car at the same rate per car for refrigeration as applied before on 27,650 pounds. This change became effective July 5, 1909. It is estimated that the value of this change to the shipper is approximately $35,000 to date, or more than half of the entire cost of the league since its organization.

In 1908 the league began a movement to prevent the duty of one cent per pound on oranges being reduced by congress and to secure an increase of one-half cent per pound on lemons for the purpose of covering the extra cost in labor expended on the lemon above the labor cost expended on the orange. The league was successful in both of these efforts, the duty standing now at one cent per pound on the orange and one and one-half cents per pound on the lemon.

The league made an investigation of the methods used by the government in determining the amount of decay in imports of lemons, and in refunding the duty to the importers on the same. The league determined that the federal system gave an advantage to the importer that was detrimental to the California citrus interests. It presented the matter to the secretary of the treasury, before whom it laid the data accumulated. A great deal of consideration has been given the question, and it is expected that the honorable secretary of the treasury will promulgate new regulations in the near future which will safeguard the interests of the government and protect the California industry from further unfair competition.

Two months after congress advanced the duty on imports of lemons from one cent to one and one-half cents a pound, the railroads, through the Transcontinental Freight Bureau, attempted to absorb part of the duty granted by congress by advancing the rate 15 cents per 100 pounds. The league secured a temporary injunction through the Circuit Court of the United States for the Southern District in California, restraining the railroad from collecting the proposed increase in rates. The commission subsequently found that the rate of $1.15 per 100 pounds on lemons was unreasonable and that the rate ought not to exceed $1 per 100 pounds.

At the same time the league questioned the reasonableness of the increased rate on lemons, and at the same time the reasonableness of the rate $1.15 per 100 pounds on oranges; and the reasonableness of the charges for refrigeration and pre-cooling charges, and the contentions of the growers were, in the main, sustained.

The league is actively engaged in an effort to sustain the import duties on citrus fruits to meet the determined efforts of importers to reduce these duties.

The league will use every effort to bring to the help of the grower special investigators from the state and federal governments to study the diseases, the insects, the soil problems, and other cultural, fruit handling and fruit transportation problems that affect the industry. It will maintain an agricultural reference library without expense to the grower, and will develop a bureau of information showing the international movement of citrus fruit and other fruits that have a relation to the industry.

The league is the only organization that has been formed by an agricultural industry in America, and probably in the world, to look after the general public policy questions that affect it. It represents 90 per cent of the growers and shippers of the state. The organization is a vital part of the industry, formed to protect and advance its interests.

The California Fruit Growers' Exchange

The greatest co-operative undertaking in fruit marketing in California is the California Fruit Growers' Exchange, organized in 1895 by the citrus fruit producers and systematically developed since that time until in scope, methods, mastery of the shipment and distribution, in development of markets and in reduced cost of placing the product therein, there is nothing comparable with it in the broad field of commercial agriculture. In March, 1911, B. A. Woodford, general manager of the exchange, prepared a careful statement of the standing and accomplishments of the organization from which the following facts, significant to producers of all kinds of fruits, are compiled:

Large and widely distributed citrus plantings began in Southern California about 1885, upon the basis of successful results attained in special localities during the previous decade. When these plantations came into bearing in considerable quantity, the ready market for cash at home that had existed for the fruit when the crop was small was found to be inadequate, and nearly 20 years ago, with an output of only 4,000 cars annually, the growers were unable to dispose of the entire crop under old methods at fair prices. Through the experience gained in their co-operative water companies, they found it comparatively easy to unite in establishing common packing houses in the various producing sections, which they themselves owned and controlled. These houses were conducted at actual cost of operation, the expenses being usually apportioned on a box basis. The purpose of the association was, primarily, to bring about uniformity in grading and packing, and to reduce the cost of preparing the fruit for sale. These economies were shared by the grower alone.

In packing their fruits on a mutual basis the growers have, however, only solved in a small degree the real problem that confronted them and, to get the full benefit of co-operation, it became necessary to extend these joint operations to the distribution and sale of the fruit. The result was the formation of the California Fruit Growers' Exchange, to which the grower entrusted the marketing of his fruit after it had been packed and placed in the car. More than 110 of these packing associations have joined together in this manner, and their business has increased from 20 per cent of the entire crop 12 years ago, to 40 per cent six years ago, and 60 per cent today.

The problem of distribution is fully as important as the problem of sale. Our crops are now so large, and the necessity of keeping our oranges and lemons before the entire consuming public is so great, that not only must the fruit be put into every possible available market, but the distribution must be even and continuous. Any other practice invites disaster. With the 110 packing houses operating through the exchange, each conducting its own business independently of the other, or with the 16 district exchanges of which the general exchange is composed, each operating independently of the other, bare markets at one point and overstocked markets at the same time in another would be the inevitable result. As it is now, with 60 per cent of the business in harmonious action, and knowing by experience about what the policy of the non-exchange shippers is, the distribution of its fruit by the exchange is conducted on a basis that assures far greater consumption at better prices than formerly when its percentage of shipments was smaller.

The organized selling force of the exchange throughout the country is one of its strongest features. This force is composed almost wholly of salaried agents, each giving his undivided attention to selling exchange oranges and lemons. This is in line with the policy of all up-to-date business enterprises, it being universally recognized that specialized service brings best results. Salaried salesmen in all important market centers is a distinctively exchange feature in citrus fruit marketing, and the exchange has 75 principal offices of its own in the United States, Canada and Europe, with over 200 salaried salesmen operating out of them, reporting sales and market conditions daily by wire.

The savings to the growers who sell their fruit through the exchange at the actual cost of operation with no profit to any individuals except the salaries that they get, run into astonishing figures when based upon the entire output of the state. Twenty million boxes of oranges and lemons have been produced in California the present season. One cent per box on this output amounts to $200,000. A few cents per box saved out of packers' profits, added to a few cents per box saved out of sellers' profits, amounts to several millions of dollars annually.

Newspaper advertising has been the greatest single factor in bringing about increased consumption of our oranges and lemons. From the experience gained through an initial expenditure of $10,000 in the first year of advertising in Iowa, and materially increased expenditures each succeeding year, with an appropriation of $100,000 for an advertising campaign that covers nearly the entire United States and Canada the present season, the exchange is now in a position to testify as to the complete success of its advertising methods. Three thousand newspapers scattered broadcast throughout the land are advertising regularly the superior merit of California citrus fruits and of California Fruit Growers' Exchange citrus fruits in particular. Such extensive publicity can only be obtained by the expenditure of a very large sum, but $100,000 means only four-fifths of a cent per box to exchange growers on this year's shipments. As our crops increase, it will be necessary to extend this advertising in various other ways at greater cost, but with increasing shipments in the exchange this is entirely practicable at only slight expense to any grower. We feel confident in predicting that there is no danger of overproduction of good fruit if the growers unite in the advertising, distribution, and sale of their oranges and lemons after they have grown them.

In obtaining packing supplies, the savings that have been made through the operations of the Fruit Growers' Supply Company, which is owned by exchange growers, are something over a half million dollars per year, as compared with conditions that formerly prevailed. The supply company is now giving its attention to the purchase of fertilizers and other orchard supplies, with a probable ultimate saving in sight which will equal or exceed what has already been done with reference to packing house supplies.

It might be of interest to know that in six seasons the exchange sold for its growers 38,962,008 boxes of oranges and lemons, for which it received $69,873,137.45 net cash f. o. b. California, or an average of $1.79 per box for every box handled, with a loss of less than $6,000 for failure to collect during the entire period.

The contrast is clearly drawn between conditions in 1892 when disaster resulted from individual action in marketing a crop of only 4,000 cars, and fair prices this season, through co-operative marketing of 60 per cent of a crop of 50,000 cars of citrus fruits.

A summary of the benefits realized to the citrus fruit industry through organized co-operation is about as follows:

1. The cost of packing, as compared with 1892, has been reduced to all growers more than 10 cents per box; a saving of $2,000,000 annually on the present output.
2. The cost of selling has been reduced more than five cents per box in the same period; a saving annually of more than $1,000,000.
3. The orange freight rate has been reduced seven cents per box; a saving on the present output of more than $1,200,000 annually.
4. The lemon freight rate has been reduced 21 cents per box; a saving on the present output of more than $500,000 annually.
5. Through reduction of refrigeration cost, the growers will finally save $500,000 annually by the recent decision of the Interstate Commerce Commission.
6. The cost of orchard supplies, particularly fertilizers, is being materially reduced through the operations of the Growers' Supply Company, with ultimate savings of $500,000 in sight.
7. Through extended advertising, the consumption of citrus fruits has been increased to keep pace with production, thus avoiding disastrous results in years of large crops, insuring to the grower a fair price for his product, while the consumer is obtaining his oranges and lemons cheaper than ever before.

The conclusions to be drawn as to future action are self-evident. The growers must be alive to their own interests at all times. They must absolutely control their own business and stand unitedly together in these great problems, such as advertising, distribution, and marketing, as well as in many other ways. Various interests are opposed to their success, and are present with plausible arguments, all based on the perfectly natural desire for private gain on the part of those who make them. With a falling off of membership in the exchange, disaster to the industry would be invited, while, on the other hand, with a constantly increasing percentage of the crop to handle, it will be possible for the exchange to confidently plan for successful future operations with the maximum of benefit to the industry and to the state, as well as showing to the world what can be done by a united body of intelligent producers through persistent organized co-operative effort.

Pomological Points — While the chief activities in the California citrus industry are commercial, as indicated, pomological points are receiving systematic attention. The types of orange and lemon varieties which best suit our growing conditions and trade requirements are quite definitely agreed upon. All the varieties which are being largely planted can be counted upon the fingers of one hand, including the Navel and Valencia for oranges, and the Eureka for a lemon—leaving two more fingers to be occupied by half a dozen minor varieties to be individually or locally contended for. It is, however, quite clear that there is a great chance for advantage in selecting variations superior in form, quality, productivity, etc., within the types, thus securing varieties which may be in many ways better than those now generally grown. The relative desirability of different stocks is also being observed in plantations made for the purpose, and the choice of buds is included. The California Experiment Station at its branches in Riverside and Whittier and in general citrus orchard studies has several experts constantly at work. The Bureau of Plant Industry of the Department of Agriculture also has men continually employed in California. It will naturally require several years to reach trustworthy conclusions in these lines.

E. J. WICKSON

CALIFORNIA FRUIT GROWERS EXCHANGE. See *Marketing*.

Canada

With the exception of Alaska, Greenland, Newfoundland and the two islands of St. Pierre and Miquelon, all of the northern half of the American continent is comprised in the Dominion of Canada. The area in square miles is 3,729,656.

The four principal surface divisions are:

1. The Appalachian region, forming the extreme southeastern corner.
2. The Laurentian Plateau or peneplain with its fringe and outliers of lowlands around the lakes and the Hudson bay, comprising the remainder of the eastern half of Canada.
3. The great Central Plain.
4. The mountain regions of the West.

Each of these divisions represents, on the whole, a different geological formation, and has its own peculiar physical features.

The Appalachian region is the northeastern extremity of a system of mountains that were pushed up from the southeast against the Archaean or Laurentian area. Nova Scotia is a part of this system, and is one of the fruit growing regions of Canada. The Laurentian Plateau or peneplain is a slight elevation of tableland resting on hard crystaline rocks everywhere scored by glaciers that created basins in which the water settled, forming lakes. The land surface is sparsely covered with soil on which grow pine, spruce and other northern trees, except in the higher altitudes, where mosses and lichens grow.

South of the Laurentian Plateau is a valley of lowlands along the St. Lawrence river. This is the great fruit growing region of Quebec, while the strips of land that skirt the Great Lakes system are the main fruit growing regions of Ontario.

The most important fruit regions of Canada are thus surrounded in whole or in part by bodies of water that modify the temperature and protect from freezing, making it possible to grow fruit at a greater distance north than it would be possible without the lakes, the ocean or other bodies of water. The Atlantic ocean and the Bay of Fundy protect parts of Nova Scotia. The Great Lakes protect part of Ontario and the Pacific ocean protects the western portion of Canada.

The Central Plain is of vast extent, reaching from the Arctic ocean south to the Gulf of Mexico, so that only a portion of this formation lies in Canada. There is very little fruit grown in this region north of the line which divides the United States and Canada, and practically none is grown for commercial purposes.

The fourth great division or mountain belt lies west of the mountains which extend from Tierre del Fuego at the extremity of South America up through the United States and Canada and to the farthest western point of Alaska.

GRANVILLE LOWTHER

The Fruit Divisions of Canada

To assist in estimating the marketable crop the fruit districts of the Dominion are divided as follows:

District No. 1—Counties north of Lake Erie and Niagara district.

District No. 2—Counties on Lake Huron and inland to York county.

District No. 3—Counties bordering on Lake Ontario north to Sharbot lake and Georgian bay.

District No. 4—Ottawa and St. Lawrence valleys to Lake St. Peter and Southwestern Quebec.

District No. 5—New Brunswick with Northeastern Quebec.

District No. 6—Hants, Kings, Annapolis and Digby counties, Nova Scotia.

District No. 7—Nova Scotia not included in District 6.

District No. 8—Prince Edward island.

District No. 9—Lower mainland and islands, British Columbia.

District No. 10—Inland valleys, British Columbia.

Districts Nos. 1, 9 and 10 ship the commercial crop of peaches and other tender fruits.

Districts Nos. 1, 2, 3, 6, 9 and 10 grow plums, pears and winter varieties of apples for long distance markets and export.

District No. 4 ships Wealthy, Fameuse, Alexander and McIntosh Red apples.

Districts Nos. 5 and 7 will not produce sufficient winter fruit for home consumption.

"F.," "L.," "M.," and "F.-C.," which appear below, are abbreviations of "Failure," "Light," "Medium" and "Full Crop," respectively, as used by our correspondents in their monthly crop reports. A combination such as "M.-F.-C." means that about an equal number of correspondents reported "Medium" and "Full Crop."

Those who would get full value from the fruit crop reports, would do well to study closely the nature of the crop in each of these districts.

District No. 1—Grows a large quantity of apples of good size, fine color and excellent quality. Their one defect is that frequently even the winter varieties ripen so early in the fall that they deteriorate very materially before the cold weather of the early winter sets in and, therefore, unless they are placed in cold storage as soon as they are matured they are apt to show a large amount of waste if any attempt is made to keep them during the winter months. The apples, therefore, in this district must, for the most part be regarded as fall and early winter varieties, unless cold storage facilities are provided to enable the holding of them for winter shipping stock. Consequently, if it should appear that there was a large crop in District No. 1, it would not materially affect the quantity of winter shipping apples, but would be counted in with the fall and early winter apples of the other districts. To this we might make the possible exception of such varieties as the Ben Davis, Stark and similar varieties that are very little grown in this district.

District No. 2—Grows excellent winter apples. It is far enough north, or the elevation above the sea level is such, that the winter varieties like the Greening, Baldwin, Spy and Russet, ripen just as the early winter sets in; consequently, these varieties may be picked and stored with advantage, as winter shipping apples in ordinary storage.

A very marked peculiarity of the district is that orchards, though numerous, are small. The district is a very large one and apples can be grown to perfection in any part of it; but the farmers are engaged, for the most part, in mixed farming.

At three or four points selling associations have been formed, and wherever these have been organized apple growing is exceedingly profitable.

District No. 3—Grows an equally good quality of winter apples; but the orchards are larger and the fruit growers are taking better care of them. Pruning, spraying and cultivating are common. The varieties planted are fewer in number and confined almost exclusively to winter apples.

Another significant feature that must be taken into account in future apple reports is that planting is being done quite freely in District No. 3. The number of young trees under 10 years old probably equals the present plantings. Consequently, each succeeding year there will be a large addition to the aggregate of the crop coming from District No. 3 as the result of new orchards coming into bearing. There will be a tendency, therefore, to underestimate the crop from this district on this account.

District No. 4—This district has a large quantity of apples of the Fameuse and Wealthy type. The climate is too severe for the standard winter varieties grown in Ontario. The varieties, such as the McIntosh Red, Wealthy, Wolfe River and a number of other hardy varieties, are all fall and early winter apples. In estimating the apple crop, therefore, consideration must be given to this fact, that a large crop of apples in District No. 4 will materially affect the market only during the fall and early winter months, and even in such cases the apples grown in this district are more desirable for dessert purposes than for cooking purposes. They, therefore, occupy a special position in the market.

District No. 5 has comparatively few trees. The quantity of fruit raised here is not enough for home consumption, so that it need scarcely be taken into consideration in an estimate of the crop for commercial purposes. This district includes New Brunswick. The possibilities of orcharding in the St. John valley are so great that there is a probability in the future of having to make a separate division of this part of District No. 5 to secure greater accuracy in the estimate.

District No. 6 is an exceedingly important one in apple production. It includes the four counties of Hants, Kings, Annapolis and Digby in Nova Scotia. It would be quite possible, considering the high state of cultivation in which a large number of the orchards are kept, to have a surplus of 500,000 or 600,000 barrels for export.

It will be readily seen that this is a very important fruit district in estimating the marketable crop for any particular year. The Gravenstein forms the largest bulk of their earliest shipments. This variety, however, is being less planted, and the district is becoming more and more confined to the winter shipping varieties. The Blenheim Orange type appears to flourish here better than the varieties so successful in Districts Nos. 1, 2 and 3. These are extremely popular in the English market, and, therefore, are always likely to be in good demand.

District No. 7 embraces the rest of Nova Scotia not included in District No. 6. A few isolated and protected valleys, particularly in the counties of Lunenburg and Digby, are demonstrating their capacity for growing fruit in commercial quantities; but as a whole it may be said that there is not enough winter fruit grown for home consumption, nor is there sufficient quantity to affect appreciably any results obtained from the other divisions.

District No. 8 includes Prince Edward Island. There is a small quantity of early fruit grown here for export, which may increase somewhat in the near future, but is not enough at present to appreciably affect the market. This district still imports winter fruit for home consumption.

District No. 9 includes the valley of the Fraser from Lytton southward, the lower coast line and the Island of Vancouver in British Columbia. This is a mild and moist climate, favorable to fruit growing, which is carried on under very different conditions from those prevailing in District No. 10.

District No. 10 includes the interior valleys of British Columbia, which have a comparatively dry, warm climate. Irrigation is required in many of these valleys, and it is, therefore, desirable that they should be grouped together, inasmuch as, though they differ among themselves slightly, yet, for commercial purposes, the fruit is similar.

Districts Nos. 9 and 10 will become in the near future much more important factors in estimating the total crop of the Dominion.

A. C. McNeill,
Chief, Fruit Division.
J. A. Ruddick,
Commissioner.

Department of Agriculture, Fruit Division, Canada.

Fruit Growing in British Columbia

Fruit growing in British Columbia is subject to most of the conditions that prevail in the northwestern part of the United States. It is farther north and, where there is no protection from the coast breezes, the temperature is colder, and, therefore, in the unprotected regions, fruits cannot be successfully grown for commercial purposes. However, there are sections where the very finest qualities of winter apples may be grown commercially, and the lands in these districts are destined to be of great value. We quote the following from W. E. Scott, of the Department of Agriculture, Victoria, B. C.:

The Province may be roughly divided for horticultural purposes into four types or sets of conditions, which are briefly described.

District No. 1—Southern half of Vancouver island and adjacent islands, with a rainfall of approximately 30 inches. This district is very well adapted for all small fruits, and is par excellence a pear country. The earlier varieties of apples and a few winter kinds do very well, also the preserving varieties of cherries. Plums, prunes and sweet cherries also yield enormous crops.

District No. 2—Lower mainland, with a rainfall of approximately 60 inches. This is essentially a district suited for small fruits and dairying. In some parts, apples and pears do well, but only those which are least susceptible to scab should be planted.

District No. 3—The interior valleys of the Province, where irrigation is necessary. These valleys are noted for the excellent quality of apples which they grow. Peaches are also grown commercially, and are successful in some parts. Pears and other fruits do well, but I would emphasize these districts particularly for apple growing.

District No. 4—Interior valleys where irrigation is not necessary. Some of the valleys in the interior of British Columbia grow an excellent quality of fruit without irrigation, though, as a rule, better results can be obtained, if water is available when required. In the Kootenay valley the quality of the fruit is excellent, and it is also noted for its long-keeping quality.

Leading Commercial Varieties Grown in British Columbia

Apples—Yellow Transparent, Duchess of Oldenburg, Wealthy, Gravenstein, McIntosh Red, Jonathan, Spitzenburg, Yellow Newtown Pippin, Northern Spy, Wagener, Rome Beauty, Golden, King of Tompkins County.

Pears—Bartlett, Louise Bonne de Jersey, Dr. Jules Guyot, Beurre Clairgeau, Beurre d'Anjou, Flemish Beauty, Beurre Hardy, Winter Nelis.

Crab Apples—Transcendent, Hyslop.

Cherries—(Sweet) Royal Ann, Bing, Lambert, Winsdor; (Preserving) Olivette and English Morello.

Plums—Peach Plum, Bradshaw, Quackenboss, Grand Duke, Black Diamond, Pond's Seedling, Yellow Egg, Italian Prune.

Peaches—Triumph, Alexandra, Yellow St. John, Early Crawford, Elberta, Belle of Georgia.

Strawberries—Magoon, Sharpless, Paxton, British Queen, Royal Sovereign.

Raspberries—Cuthbert.

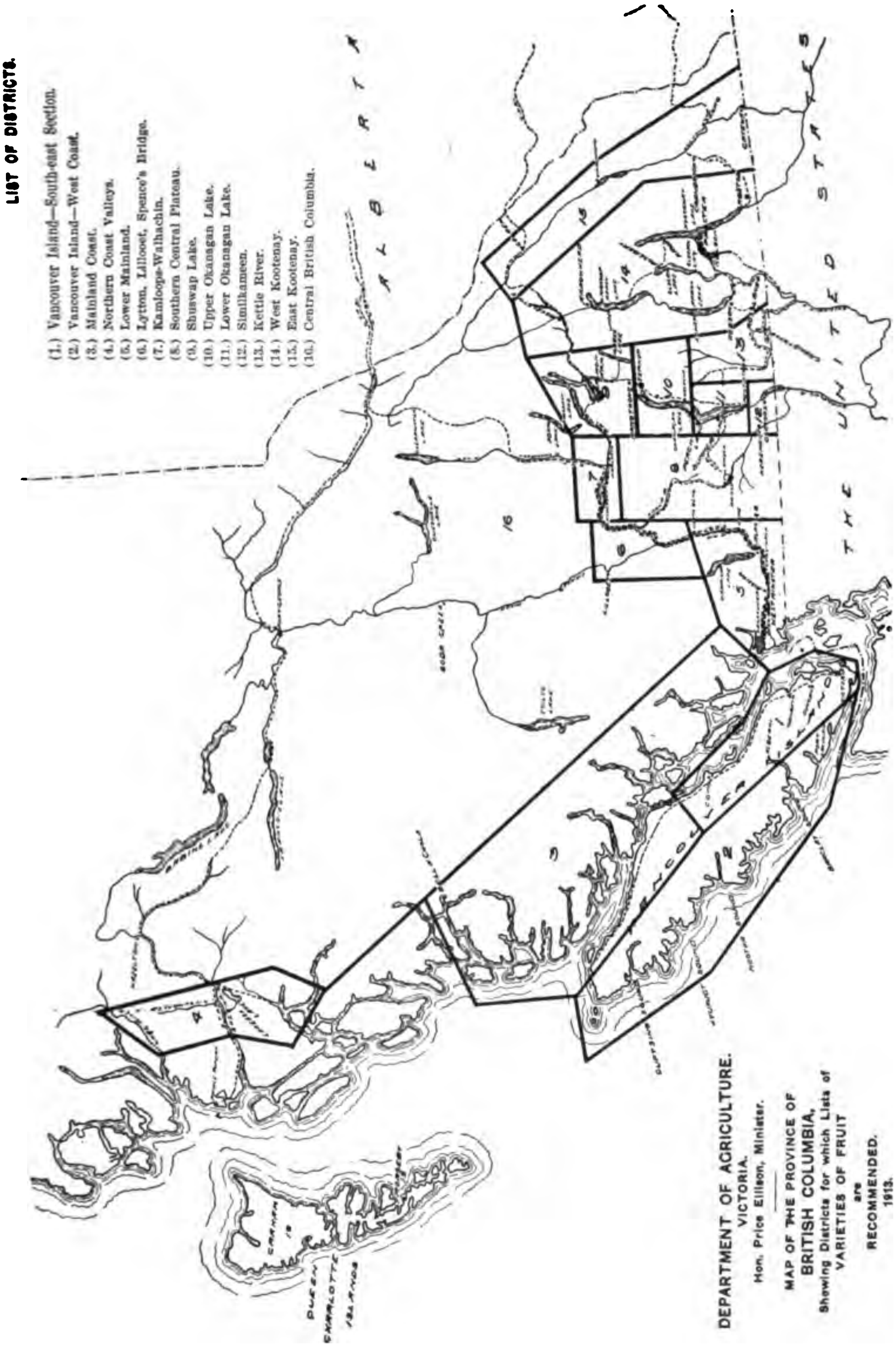
LIST OF DISTRICTS.
(1.) Vancouver Island—South-east Section.
(2.) Vancouver Island—West Coast.
(3.) Mainland Coast.
(4.) Northern Coast Valleys.
(5.) Lower Mainland.
(6.) Lytton, Lillooet, Spence's Bridge.
(7.) Kamloops-Walhachin.
(8.) Southern Central Plateau.
(9.) Shuswap Lake.
(10.) Upper Okanagan Lake.
(11.) Lower Okanagan Lake.
(12.) Similkameen.
(13.) Kettle River.
(14.) West Kootenay.
(15.) East Kootenay.
(16.) Central British Columbia.
ALBERTA
THE UNITED STATES
VANCOUVER ISLAND
QUEEN CHARLOTTE ISLANDS
GRAHAM IS
DEPARTMENT OF AGRICULTURE.
VICTORIA.
Hon. Price Ellison, Minister.
MAP OF THE PROVINCE OF
BRITISH COLUMBIA,
Showing Districts for which Lists of
VARIETIES OF FRUIT
are
RECOMMENDED.
1913.

Fig. 1. Map Showing the Location of the Various Horticultural Districts of British Columbia.

Varieties of Apples Recommended for the Various District in British Columbia

DISTRICTS									
1	5	6	7	9	10	11	12	13	14
King (1) 3,000, B	King (1) 2,000, B	Grimes (1) 1,000, E	Grimes (1) 500, D	Spy (1) 2,000, E	Wealthy (1) 12,000, D	Jonathan (1) 6,000, A	McIntosh (1) 600	Wealthy (1) 2,000. B	Wealthy (1) 2,000, D
Wealthy (2) 4,000, A	Wealthy (2) 1,500, E	Jonathan (2) 1,200, A	Jonathan (2) 700, A	Russet 2,000	Crabs (2) 42,000, E	Wagener (2) 4,000, C	Jonathan (2) 1,800, A	McIntosh (2) 2,500, C	Wagener (2) 4,000, A
Duchess (3) 1,500	Spy 3,000, A	Spitzenburg 1,200, B	Spitzenburg E	Pewaukee 2,300	McIntosh (3) 24,000, C	Spitzenburg 3,000, B	Wagener (3) 1,500, E	Jonathan (4) 5,000, A	McIntosh (3) 3,000, C
Spy 1,000, C	Blenheim	Spy 1,000, D	Winesap (3)	Ben Davis 1,200	Jonathan (4) 30,000, A	Y. Newton (3) 2,500, D	Spitzenburg (4) 800, B	Wagener 800	Spy (4) 1,500, E
Blenheim (4) 1,000	Jonathan	Ben Davis 1,500, C	Rome Beauty	Wealthy (2) 2,800, D	Wagener 20,000, B	Cox Orange 2,000, E	Newtown (5) 1,000, C	N. Spy (3) 1,500, D	Spitzenburg 600
Ribston 800	Ben Davis 2,000, C	Winesap (3) 2,000, F	Wealthy (5) C	Wagener (3) 1,200, A	Spitzenburg 10,000, G	Grimes (4) 1,000, F	Baldwin 1,500	Spitzenburg 600, E	Jonathan (6) 3,000, B
Baldwin 1,500, D	Baldwin 3,000, D		McIntosh (4) B		Spy (5) 6,000, F	Wealthy 3,000	Winesap (6) 1,000, D	Newtown 1,200, F	Newtown 800
	Grimes (3) 1,000, F		Wagener F	McIntosh (4) 1,200, C	Y. Newtown 8,000	Crabs 1,500	Bellflower 1,500	Rome Beauty 800, G	Gravenstein (5) 1,500, F
				Jonathan (5) 2,500, B	Cox Orange 5,000	Winesap 1,800, G	Ben Davis 1,800	Delicious 400	King 400
					Ben Davis 7,000	Rome Beauty 600		Winesap 1,200	Baldwin 1,000, G
Total cars. 40	30	15	10	45	450	100	25	45	70

1. The figures in parenthesis, (1), (2), etc., indicate varieties being most successfully grown.
2. Quantity produced, *in boxes*. Official figures not yet available, but above will be found reasonably accurate.

Note. Estimate in cars includes many other varieties.

3. Letters give varieties in order of number of trees planted.

Export Fruit Packages, Etc., in British Columbia

Inside Measurements.

	Size of Box, etc., Inches	Average Weight (Net)	Remarks
Apples	10 x 11 x 20	41 lb.	
Crab Apples	10 x 11 x 20 (apple)	50 lb.	The half apple box is also used on the Lower Mainland.
	18¼ x 11 x 8½ (pear)	40 lb.	As used in Upper Country; half pear box and peach box (20 lb.) also sometimes used.
Pears	18¼ x 11 x 8½	46-48 lb.	
Peaches	18¼ x 11¾ x 4	17-21 lb.	
	18¼ x 11¾ x 4¼		
	18¼ x 11¾ x 4½		
Plums	15¾ x 15¾ x 4¼	20-22 lb.	4-basket crate.
Prunes		20-25 lb.	Shipped largely in peach boxes.
Apricots	15¾ x 15¾ x 4¼	19-20 lb.	4 basket crate.
Cherries	18½ x 9 x 2¼	8½-9 lb.	Sour cherries (4-basket crate), equals 16-18 lb. Sour cherries (special pack), equals 24 lb.
Raspberries	2-5 quart carton (24 to 1 crate); size of carton, 5¼ x 5¼ x 1	14 lb.	Size of crate, 16¾ x 23¼ x 5¼.
Strawberries	4-5 quart carton (24 to 1 crate); size of carton, 5⅞ x 5¼ x 8	24 lb.	Size of crate, 16¾ x 23¼ x 6¾.
Loganberries	2-5 quart carton (24 to 1 crate)	16 lb.	
Currants			As for strawberries.
Grapes	6-quart basket (approximately)		Six 6-quart baskets reckoned as 100 lb. by the Express Co.
Rhubarb	20 x 15¾ x 7¾	40 lb.	
Cantaloupes	12 x 11½ x 20¼		
Tomatoes	18¼ x 11¾ x 5	23 lb.	
Cabbage	25 x 23 x 18		
Lettuce	28¼ x 16 x 12		

Horticulture in Nova Scotia

The horticultural industry of Nova Scotia is generally supposed to be carried on chiefly in a small section of the western part of the Province. While it is true that the present production of orchard fruits is largely confined to the Annapolis, Cornwallis and adjacent valleys, there are many other parts of the Province where these fruits can be grown, and where small fruits and market garden crops can be as successfully grown as in the so-called orchard district. The nearness of many of these places to mining towns and manufacturing centers gives them the advantage of a local market where fresh garden products find a ready sale at good prices. In such localities intensive methods on small areas often bring surprisingly large profits. Strawberries and bush fruits, asparagus, beans, celery, lettuce, rhubarb, peas, tomatoes, roots and early potatoes are some of the crops which have been found profitable in this kind of farming. It is probable that a history of horticulture written for the Province a quarter of a century or more hence will have to include a large reference to this industry in these other counties. But, in the meantime, fruit growing is developed to such a greater extent in the Annapolis valley that these articles, more especially insofar as they are historical, apply largely to this part of the Province. If, however, the same principles which have made fruit growing in Kings and adjoining counties successful were applied in the other counties of the Province, the industry would become much more extensive than at present. The following articles are accordingly commended to all citizens of Nova Scotia, whether living within or without the Annapolis and nearby valleys.

For the last 30 years the production of fruit from the orchards of Nova Scotia has been steadily increasing. The yearly income from the sale of fruit exported now amounts to about $1,500,000. Considering the number and extent of the young orchards just coming into bearing, there seems every reason to believe that the future rate of increase will be still more rapid, and that the annual returns for the years immediately succeeding 1910 will probably exceed $2,000,000. The business of fruit growing in Nova Scotia offers an opportunity for the investment of capital as safe as that afforded by any business in the Province.

The best fruit growers are constantly trying to understand and to reduce to practice the principles of horticultural science. With these men annual cultivation of orchard lands is the rule. Cover crops are grown. Stable manure, commercial fertilizers, or both, are yearly applied. Fruit trees are so pruned as to admit the air and sunlight to the growing fruit, to remove weak and dying or interfering branches and to encourage and maintain a healthy, continuous growth of the tree. Three or more sprayings with a poisoned fungicide are given each year to control insect pests and fungous diseases. Formerly Bordeaux mixture was the only fungicide used, but lately the lime-sulphur wash has been tried by some of the best orchardists with apparently good results. This mixture was first brought into use in orchards to combat the San Jose scale. It was soon found, however, that, besides being an insecticide, it had an important fungicidal value and, though the dreaded scale has not yet made its appearance in Nova Scotia, the lime-sulphur wash is being used both as a dormant and a summer spray.

It is important to notice that in starting an orchard the returns are far more remote than in other lines of farming. Under the ordinary method of treatment, an apple orchard gives little, if any, income during the first 10 years. There is, however, an annually accruing value in the growth of the trees, which more than offsets the expenses incurred in their care. Almost all the bearing orchards in the fruit district today were grown while the owners were engaged in other kinds of farming. But when the profits of orcharding became apparent, this branch of agricultural industry took first place. While other lines of farming are now secondary to orcharding in the fruit district, they are nevertheless of considerable importance in providing a source of income until the young orchard comes into bearing, paying expenses during years of poor crops or low prices, or providing a means for using the product of natural hay lands, and thus supplying manure for the orchard. The raising of small fruits, market gardening, dairying, beef or poultry raising, or other branches of agriculture to which the farm may be best suited, provides an excellent side line to orcharding.

In years of ordinarily good crops of fruit, about seven-eighths of the marketable apples produced in Nova Scotia find a sale in foreign countries. The chief market is in Great Britain, although there is now a growing trade with Newfoundland, the West Indies, and South Africa. Our proximity to the British market and the comparative cheapness of water transportation give Nova Scotian growers an advantage over their competitors. The varieties of apples generally grown in England are found to succeed well here, and our growers aim to secure such varieties as are popular with the British consumer.

The fruit industry, however, has now reached a stage in which the proper varieties of trees to plant, the proper care of the growing trees, and the handling of the fruit are fairly well understood. The next step in the natural development of the industry is now being taken in the formation of co-operative associations of fruit growers for the marketing of fruit. The proper marketing is as important as the growing of fruit. Without organization the producers are at the mercy of the transportation companies and of dealers at home and abroad, who are generally understood to be combined and well organized. The result is that the amount received by the producer of the fruit is often less than half the amount paid by the consumer. To secure their share of the return from the industry, the producers must be as well organized as are the men with whom they deal. Ten co-operative associations have already been formed in the fruit-producing district of Nova Scotia, and the organization of these into one central association has now been effected.

The following articles from successful horticulturists give some idea of the profit derived from orcharding and gardening in Nova Scotia. They also, to an extent, describe the methods by which these results have been obtained. While not by any means exhaustive in their treatment of the subject, they touch upon all the operations of importance in connection with fruit growing, and will be found instructive, suggestive and most encouraging.

P. J. SHAW,

(Annual Report Secretary of Agriculture, N. S., 1910.)

Export Figures from 1880 to 1910

1880-1885	23,920
1885-1890	83,249
1890-1895	118,552
1895-1900	259,200
1900-1905	330,406
1905-1910	482,298

The prices have ranged at from $2 to $2.25 per barrel.

Fifty Per Cent Increase

From the above figures we observe that the average export of the last five years has been over 20 times that of the same period 25 years ago. Also that, though the increase for the first 10 years of our export business was greater than the last 10 years, yet the increase for the last three five-year periods has been approximately even, and shows the export of each period to be about 50 per cent more than the previous one. Four periods out of the six show approximately this increase.

It is estimated by the railway authorities that during the last few years quite 150,000 barrels per year have been consumed in the Province, which should be added to the above 482,298 to show our actual production during the last five years. There is little doubt that the quantity used in our Province during the last 15 years has increased in equal proportion to our export.

RALPH S. EATON,
Kentville, N. S.

(In Annual Report of Secretary of Agriculture, N. S., for 1910.)

FRUITS OF ONTARIO

When the first fruit trees were planted in Ontario, probably about 150 years ago, the settlers had no reliable information to guide them in selecting varieties or in caring for the trees after they were planted. But the experience of these early settlers was taken advantage of by their descendants who, with the additional knowledge possessed, were able to make some progress, although scattered as they were in those early times without good means of intercourse. The dissemination of information from one to another and to the new settlers who were coming in was slow until the railways were built. Then fruit growing became much more general, as trees could be easily transported from one part of the Province to another. In 1859 a few enthusiastic horticulturists organized the Ontario Fruit Growers' Association. Meetings were held in different parts of the Province, and the people were urged to plant more fruit. This organization has, for the past 47 years, by its meetings, annual reports, the *Canadian Horticulturist*, and in many other ways, done very much to bring about the present development in the fruit industry of Ontario. Realizing that more definite information was needed to guide fruit growers in the planting of varieties and the culture of fruits, the association in 1893 urged upon the government the importance of establishing fruit experiment stations throughout the Province. The idea received the approval of the government, and in 1894 four stations were established, this number being increased to 13 in the course of a few years. To these were sent many varieties of fruits, which were tested and reported upon each year by those in charge of the stations. As these experimenters were all practical fruit growers, and in most cases had made a specialty of some kind of fruit, much valuable information regarding varieties and their culture was accumulated by the department of agriculture.

Tree Fruits

Among what are commonly classed the tree fruits are the **apple**, cherry, peach, pear, plum and quince.

The importance of the fruit interests may be fairly judged by the following figures for Ontario from the Dominion census of 1901:

	Not Bearing	Bearing	Total Trees	Bushels	Value	Acres	Capita
Apple Trees........	1,989,983	7,551,636	9,541,619	13,631,264	$3,407,815	228,013	$34.3
Peach Trees.......	470,772	811,725	1,282,497	539,482	539,482	38,002	11.4
Pear Trees.........	280,175	564,798	844,973	487,759	365,819		
Plum Trees........	686,628	909,091	1,685,719	337,108	252,831		
Cherry Trees......	237,792	446,556	684,348	132,177	297,398		
Total.........	3,665,350	10,373,806	14,039,156	15,127,790	4,863,345	266,015	45.

There has been a marked increase in the number of acres planted since the 1901 census was taken, the total number of apple trees, according to the last report of the Ontario Bureau of Industries, being 10,201,766.

THE APPLE

From the Ottawa river, which bounds the Province on the east, to the Great Lakes on the west, a distance of about 500 miles, and from the St. Lawrence river and Great Lakes on the south to latitude 45 degrees, and even 46 degrees, on the north, a distance of about 280 miles, there are many flourishing commercial apple orchards. These produce annually an average crop of about 35,000,000 bushels of fruit. But apple growing is not confined even to this area, for scattered here and there over the newer parts of Ontario almost up to the Manitoba boundary are trees which are bearing good apples and supplying the settler with fruit for home consumption.

Owing to the material difference in climatic conditions between the extreme southern and the northern parts of the Province, some varieties of apples are more adapted to certain sections than others, not only on account of their varying degrees of hardiness, but because some kinds produce better fruit in certain sections than in others. Furthermore, as apples grown in the southern parts of the Province do not keep as well as those grown in the northern sections the fruit matures earlier, and hence does not come into keen competition with, perhaps, the same varieties from other sources. Each part of the Province therefore, where apples are grown can produce fruit which has a fair chance of commanding the highest price on the market. As these climatic conditions cannot be changed, it behooves fruit growers in the southwestern peninsula to make a specialty of growing fruit for the early markets, for there is no other section which can compete so favorably in the production and sale of early apples especially for the rapidly growing market in the Northwest.

Varieties Recommended

General Lists—After testing a large number of varieties of fruit at the various fruit stations, the board of control has decided upon the following as the most desirable for general planting.

District Lists—The district lists given by the various experimenters show vari eties especially adapted to the sections represented by their stations.

The term *Commercial* is intended to include the varieties most desirable for market purposes, and the term *Domestic* those most desirable for home uses, either cooking or dessert.

These lists are given, as far as possible, in the order of ripening.

It is realized that there are many varieties not included in these lists which may do well *under special conditions*, yet which are generally not considered as desirable as those mentioned.

General List of the Most Valuable Varieties for Market Approved by the Board of Control

Summer

ASTRACHAN—Adapted to all sections except the extreme north.

DUCHESS—Adapted to all sections.

Fall

GRAVENSTEIN—Adapted to all sections except the St. Lawrence river and other northerly portions of the Province.

WEALTHY — Particularly valuable for northern sections.

ALEXANDER — Especially for northern districts.

MCINTOSH—Adapted especially to the St. Lawrence river district, but can be grown over a much wider area.

FAMEUSE—Adapted especially to the St. Lawrence river district, but succeeds well over a much wider area.

BLENHEIM—Adapted to all sections except the St. Lawrence river district and northerly portions of the Province.

Winter

KING—Adapted only to the best apple sections, and succeeds best when top grafted on hardy stocks.

HUBBARDSTON — Adapted to the best apple sections.

GREENING—Adapted to the best apple sections.

BALDWIN—Succeeds best on clay land, and is adapted to the best apple districts.

SPY—Adapted to the best apple districts, but can be grown with success farther north by top-grafting on hardy stocks. This is also a good method of bringing it into early bearing.

ONTARIO—An early and abundant bearer, but short-lived. Recommended as a filler among long-lived trees. Adapted to same districts as Northern Spy, which it somewhat resembles.

STARK—Adapted to best apple districts.

Varieties Especially Adapted to Home Use

Summer

TRANSPARENT—Adapted to all sections.

PRIMATE—Adapted to best apple sections.

SWEET BOUGH — Adapted to best apple sections.

DUCHESS—Adapted to all sections.

Fall

CHENANGO—Adapted to best apple sections.

GRAVENSTEIN—Adapted to best apple sections.

WEALTHY—Especially adapted to northern sections.

MCINTOSH—Especially adapted to northern sections.

FAMEUSE—Especially adapted to northern sections.

BLENHEIM—Adapted to best apple sections.

Winter

KING—Adapted to best apple sections. Should be top-grafted.

WAGENER—Adapted to best apple sections.

SWAYZIE—Adapted to all sections except most northerly.

GREENING—Adapted to best apple districts.

TOLMAN—Adapted to best apple districts.

SPY—Adapted to best apple districts, but will succeed farther north if top-grafted.

MANN—Adapted to best apple districts, but will succeed farther north if top-grafted.

Hardy Varieties Recommended for Sections North of Latitude 46 Degrees

Summer

Yellow Transparent, Charlamoff.

Fall and Winter

Duchess, Wealthy, Hibernal, Longfield, **Patten**, Whitney, Hyslop, Scott Winter.

Crabs Suitable for the Whole of the Province

Whitney—A large crab of high quality, suitable for planting in the extreme north where other apples will not succeed. May be used for dessert or cooking.

Martha—An early crab of fair quality.

Transcendent—Yellowish crab, season early autumn.

Hyslop—Dark, rich red crab, of late season, quality only fair.

District Lists Recommended by the Experimenters

Niagara District

Linus Woolverton

Grimsby, Ont.

Commercial — Astrachan, Gravenstein, Duchess, Alexander, Blenheim, Cranberry Pippin, Hubbardston, King, Greening, Baldwin, Spy.

Domestic—Early Harvest, Gravenstein, Sweet Bough, Chenango, Duchess, Shiawassee, Fall Pippin, Fameuse, Swayzie, Wagener, Yellow Bellflower, Spitzenburg, Tolman.

Bay of Quinte District

W. H. Dempsey

Trenton, Ont.

Commercial — Duchess, Gravenstein, Trenton, Alexander, Wealthy, Fameuse, McIntosh, King, Greening, Baldwin, Ontario, Seek-no-Further, Spy, Tolman, Ben Davis, Stark.

Domestic — Benoni, Primate, Gravenstein, Fameuse, McIntosh, Grimes, Greening, Ontario, Spy, Tolman, Swayzie.

Burlington District

A. W. Peart

Burlington, Ont.

Commercial — Astrachan, Duchess, Wealthy, Ribston, Blenheim, King, Greening, Baldwin Spy.

Domestic — Astrachan, Sweet Bough, Gravenstein, Wagener, Seek-no-Further, Golden Russet.

Lake Simcoe District

G. C. Caston

Craighurst, Ont.

Commercial—Duchess, Peerless, Alexander, Wolf River, Blenheim, Pewaukee, Stark, and the following if top-worked on hardy stocks: Greening, King, Ontario, Baldwin, Spy.

Domestic—Astrachan, Primate, St. Lawrence, Fameuse, McIntosh, King, Spy.

Lake Huron District

A. E. Sherrington

Walkerton, Ont.

Commercial — Astrachan, Duchess, Wealthy, Fameuse, McIntosh, Blenheim, Greening, Baldwin, Spy, Golden Russet, Ben Davis.

Domestic — Transparent, Astrachan, Duchess, McIntosh, Grimes, Blenheim, King, Spy, Golden Russet.

St. Lawrence District

Harold Jones

Maitland, Ont.

Commercial—Duchess, Alexander, Wolf River, Scarlet Pippin, Fameuse, McIntosh, Baxter, Milwaukee, Golden Russet.

Domestic — Transparent, Brockville, Beauty, Scarlet Pippin, Fameuse, McIntosh, Blue Pearmain, Golden Russet, Yellow Bellflower.

Algona District

Charles Young

Richard's Landing, Ont.

Commercial and Domestic—Astrachan, Transparent, Duchess, Charlamoff, Gideon, Longfield, Wealthy, Scott Winter.

THE PEAR

The pear succeeds all over the best apple districts of Ontario, but few good hardy varieties have yet been found, hence the commercial culture of the pear does not extend as far north as the apple. The principal pear orchards are found in Southern Ontario. There are many good orchards, however, along Lake Ontario as far east as the Bay of Quinte and north to the Georgian Bay.

In Eastern Ontario, only a few kinds succeed, and these are not planted on a commercial scale. These hardy varieties are grown to a limited extent for home use as far north as latitude 45 degrees and some of the Russian pears, though inferior in quality and very subject to blight, may be grown still further north.

The pear stands distant shipment well if picked at the right time, and properly packed and handled in transit, and hence larger quantities are being sent to distant markets every year, and as a rule good prices are obtained for the fruit.

Varieties Recommended
General List Approved by the Board of Control

COMMERCIAL—Giffard, Clapp, Bartlett, Boussock, Flemish (hardy, subject to spot), Howell, Louise, Duchess, Bosc, Clairgeau, Anjou, Kieffer.

DOMESTIC — Summer Doyenne, Giffard, Bartlett, Flemish (for the north), Sheldon, Seckel, Bosc, Anjou, Lawrence, Josephine, Winter Nelis.

District Lists Recommended by the Experimenters

Niagara District

LINUS WOOLVERTON
Grimsby, Ont.

COMMERCIAL—Chambers, Wilder, Giffard, Clapp, Bartlett, Hardy, Bosc, Howell, Louise, Duchess, Pitmaston, Clairgeau, Anjou, Easter Beurre.

DOMESTIC — Doyenne, Manning, Giffard, Boussock, Rostiezer, Marguerite, Sheldon, Seckel, Triumph, Ritson, Louise, Hardy, Diel, Anjou, Lawrence.

Burlington District

A. W. PEART
Burlington, Ont.

COMMERCIAL—Wilder, Clapp, Bartlett, Boussock, Louise, Duchess (dwarf), Anjou, Kieffer, Winter Nelis, Easter Beurre.

DOMESTIC — Wilder, Bartlett, Louise, Anjou, Winter Nelis.

Bay of Quinte District

W. H. DEMPSEY
Trenton, Ont.

COMMERCIAL AND DOMESTIC — Giffard, Tyson, Clapp, Boussock, Hardy, White Doyenne, Dempsey, Bosc, Clairgeau, Goodale, Lawrence, Josephine.

St. Lawrence District

HAROLD JONES
Maitland, Ont.

DOMESTIC—Clapp, Flemish, Ritson.

THE PLUM

The plum has a wider range over the Province of Ontario than the pear or peach, this fruit being a native of the Province and found as far north as Manitoba.

There are three large groups into which the plums may be divided here, namely, the European, Japanese, and American. In the European or domestica group are included most of the varieties which are grown in Ontario commercially. These plums are not as hardy as the natives, hence their profitable culture is limited to almost exactly the same districts as the pear, the commercial orchards being mostly found in Southern Ontario, the Georgian Bay District, and along Lake Ontario west of the Bay of Quinte. A few of the hardiest produce crops occasionally in Eastern Ontario and up to about latitude 45 degrees in Central Ontario, but they are too uncertain to be grown for profit.

The Japanese plums are grown over practically the same area as the European, but the fruit buds average a little more tender.

In the American group are included the Americana and Nigra plums, the former being derived from a hardy United States species and the latter from the native Canadian plum. The varieties of this group are quite hardy and can be grown commercially where the European and Japanese plums will not succeed, and while not so good in quality as the others, good prices are at present obtained for what are produced.

Plums are not being so extensively planted at present as other large fruits, since during recent years the markets have several times been glutted, resulting in low prices. The demand for plums is, however, always large, and the excellent market which is opening up in the Northwest will probably in the future prevent, in a great measure, this over-supply.

The cultural directions for the apple will apply in most particulars to the plum, which will succeed on almost all kinds of well drained soils, although it does best on the heavier clay loams. Trees one or two years of age should be planted about eighteen feet apart each way, the soil having been thoroughly prepared beforehand. The trees should be severely headed back when planted, and future pruning will consist in forming a well shaped open head. As some varieties make exceptionally strong growth it is a good practice when the trees are young to prune the young growth back about one-half each spring to avoid splitting. When the trees begin to bear little pruning is necessary, as they usually bear so heavily that the trees do not make much growth annually.

Orchards should be kept thoroughly cultivated, and cover crops are recommended as for the apple, cherry, peach and pear. The fruit should be picked when it is well colored but still firm.

Varieties Recommended

General List Approved by the Board of Control

COMMERCIAL AND DOMESTIC—

AMERICAN—These are extremely hardy and are desirable where the European and Japanese varieties cannot be grown: Aitken, Cheney, Bixby, Mankato, Wolf, Hawkeye, Stoddard.

EUROPEAN—Bradshaw, Imperial Gage, Gueii, Shipper Pride, Lombard (liable to overbear, requires thinning), Quackenboss, Yellow Egg, Grand Duke, Coe, Reine Claude (one of the best for canning).

JAPANESE—These are apparently quite as hardy as the European varieties: Red June, Abundance, Burbank, Chabot, Satsuma (red fleshed, desirable for canning).

District Lists Recommended by the Experimenters

Lake Huron District

A. E. SHERRINGTON
Walkerton, Ont.

COMMERCIAL AND DOMESTIC—Red June, Ogon, Burbank, Bradshaw, Imperial Gage, Gueii, Shipper Pride, Victoria, Quackenboss, Yellow Egg, Monarch, Grand Duke, Satsuma.

Georgian Bay District

JOHN MITCHELL
Clarksburg

COMMERCIAL AND DOMESTIC—Red June, Burbank, Washington, Bradshaw, Imperial Gage, Quackenboss, Arch Duke, Diamond, Monarch, Yellow Egg. Coe, Satsuma, Reine Claude.

Burlington District

A. W. PEART
Burlington, Ont.

COMMERCIAL—

EUROPEAN—Bradshaw, Imperial Gage, Lombard, Yellow Egg, Glass, Reine Claude.

JAPANESE—Red June, Abundance, Burbank, Chabot, Satsuma.

DOMESTIC—Abundance, Saunders, Bradshaw, Imperial Gage, Smith Orleans, Lombard, Yellow Egg, Satsuma, Reine Claude

Niagara District

LINUS WOOLVERTON
Grimsby, Ont.

COMMERCIAL—Red June, Burbank, Bradshaw, Chabot, Gueii, Coe, Quackenboss Satsuma, Reine Claude.

DOMESTIC — Abundance, Washington Yellow Egg, Shropshire, Quackenboss Satsuma, Reine Claude.

St. Lawrence District

HAROLD JONES
Maitland, Ont.

DOMESTIC—

NOTE—*The European and Japanese varieties are only recommended for the home garden in the St. Lawrence District, as they have not proved entirely hardy nor very productive.*

AMERICAN—Milton, Whitaker, Hammer.

EUROPEAN—Gueii, Lombard, Shipper Pride, Glass.

JAPANESE—Red June, Burbank.

THE GRAPE

There is no more popular fruit than the grape, and, owing to the rapid increase in population during recent years, the demand for grapes is constantly growing. For this reason the planting of grapes, which was in a large measure suspended for a few years, is steadily increasing, many vineyards now being established annually.

The grape requires a comparatively dry hot season for the development of good flavor and the perfect ripening of the fruit, and as most of the cultivated varieties will not stand very low temperatures unless protected, the grape suc ceeds best in the most southern parts of the Province, the commercial vineyards being confined almost entirely to the Niagara peninsula, and to the district bordering Lake Erie. The grape can, however, be grown successfully over a much wider area than this, and where the summer temperature is fairly high and spring and early autumn frosts are rare, large quantities of grapes are grown for home consumption. Hence the early varieties of this fruit may be ripened pretty generally over the Province as far north as latitude 45 degrees and probably further.

Varieties Recommended

General List Approved by the Board of Control

COMMERCIAL AND DOMESTIC—

BLACK—Moore, Campbell, Worden, Concord, Wilder.

RED—Delaware, Lindley, Agawam, Vergennes.

WHITE—Niagara, Diamond.

FOR NORTHERN SECTIONS—

BLACK—Champion, Moore, Campbell, Worden, Wilder.

RED—Moyer, Brighton, Delaware, Lindley.

WHITE—Winchell, Diamond.

District Lists Recommended by the Experimenters

Wentworth District

M. PETTIT

Winona, Ont.

COMMERCIAL—

BLACK—Champion, Campbell, Worden, Concord.

RED—Delaware, Lindley, Agawam, Vergennes, Catawaba.

WHITE—Niagara, Diamond.

Niagara District

LINUS WOOLVERTON

Grimsby, Ont.

DOMESTIC—Moyer, Campbell, Worden, Delaware, Lindley, Brighton, Wilder, Agawam, Requa.

BUSH FRUITS

In Bush Fruits are included the Blackberry, Currant, Gooseberry, and Raspberry. These fruits, while not being of quite so much importance from a commercial standpoint as the tree fruits, are grown and consumed in very large quantities in Ontario, and as they are used in many ways by housekeepers there will always be a demand for them. They can be grown between the tree fruits to advantage while the latter are young and hence often augment the revenue of the fruit grower materially before the tree fruits come into full bearing.

Some idea of the large quantities of bush fruits which are grown will be obtained from the Dominion census statistics for 1901, where it is stated that there were at that time 8,116 acres devoted to small fruits in Ontario, on which were produced about 16,000,000 quarts valued at $811,000.00. The strawberry is included in the above estimate. The present area devoted to small fruits is estimated at 10,000 acres.

THE BLACKBERRY

The blackberry is not grown so largely in Ontario as it might be. It is one of the most profitable fruits to grow where it succeeds well, but as the crop is rather uncertain except in Southern Ontario and in localities farther north where it is protected by a deep snow fall, its range of successful culture is somewhat limited. Where there is not danger of winter killing, a well drained clay loam is probably the best for the blackberry, as it is cooler and more retentive of moisture than lighter soils. The blackberry must have plenty of soil moisture when the fruit is ripening, otherwise but little of the crop will develop. Further north, where hardiness is of greater consideration than conservation of moisture, the poorer and warmer soils are preferred, as the blackberry on these soils does not make as rampant a growth and hence ripens its wood better.

Varieties Recommended

General List Approved by the Board of Control

Agawam, Snyder, Eldorado, and for southern sections, Kittatinny.

District Lists Recommended by the Experimenters

Burlington District

A. W. Peart
Burlington, Ont.

Commercial and Domestic—Snyder, Briton, Triumph, Agawam, Taylor.

Lake Simcoe District

G. C. Caston
Craighurst, Ont.

Commercial and Domestic—Agawam, Eldorado.

THE CURRANT

The currant is a very hardy fruit and for this reason can be grown with success all over the Province of Ontario, and as fair results are obtained without high culture, almost everyone who has a garden grows currants. Like all other fruits, however, the currant becomes most profitable when it is given good care.

The currant is a moisture loving fruit, hence for profit it should be planted in a cool, moist, but well drained soil. It also requires rich soil, hence as a rule the best is a good clay loam which is retentive of moisture and cooler than sandy loam. The soil should be thoroughly prepared for currants before planting. One year old plants from cuttings if strong will give good satisfaction, although two year old plants are not too old. They should be planted in rows about six feet apart, and from four to five feet apart in the rows, the wide distance being more satisfactory for the strong growing varieties and especially black currants. Fall planting is best for currants, as the buds start very early in the spring and should these develop before they can be planted, their future growth will be checked. They can, however, be planted in the spring with success. The plants should be set a little deeper than they were in the nursery, and the soil well pressed against the roots. Thorough cultivation should follow to promote as much growth as possible, but it should be shallow, as the currant roots are near the surface. The following spring the currants will need some pruning to give them a shapely open head, the bush when well shaped having from five to seven main branches well distributed to avoid crowding. The fruit of red currants is formed from spurs on wood two years old, while the fruit of black currants is borne on wood of the previous year. Currants should be pruned annually to get the best results.

Varieties Recommended

General List Approved by the Board of Control

Black—Black Victoria, Champion, Lee, Naples, Saunders.

Red—Cherry, Fay, Pomona, Red Cross, Victoria, Wilder.

White—White Grape.

District Lists Recommended by the Experimenters

Burlington District

A. W. Peart
Burlington, Ont.

Commercial—

Black—Lee, Naples, Saunders.

Red—Cherry, Fay, North Star, Prince Albert, Victoria, Wilder.

White—White Grape.

Lake Huron District

A. E. Sherrington
Walkerton, Ont.

Black—Champion, Naples, Saunders.

Red—Pomona, Red Cross.

THE GOOSEBERRY

The gooseberry and the currant are the two hardiest bush fruits which are cultivated, and the gooseberry, like the currant, succeeds in all parts of the Province, although the hardy gooseberries are confined to the varieties derived from the native species and to crosses between the native and the European. The European varieties are only grown successfully in favored locations as in most places they are very subject to mildew.

The gooseberry, like the currant, requires a cool, moist, though well drained soil to give the best results, and suffers more than almost any other fruit in a dry time. These cool, moist conditions are best obtained as a rule by planting in a well drained friable clay loam. The soil should be thoroughly prepared, as although the gooseberry will give a fine crop of fruit, even if not well cared for, the size will be small. Gooseberries may be planted with success either in spring or fall, but fall planting is preferable, as growth begins early and plants usually receive a severe check if planted in the spring.

Varieties Recommended

General List Approved by the Board of Control

Pearl, Downing, Red Jacket. Whitesmith is one of the best English varieties, but is almost valueless on some soils and in some localities owing to mildew.

THE RASPBERRY

Next to the strawberry, the raspberry is the most popular bush fruit grown in Ontario, and as it follows the former in season the consumer is well supplied with these two fruits most of the summer. The raspberry being a native of Ontario, is hardy in almost all parts of the Province, hence it is cultivated over a very wide area.

Like the other bush fruits, the raspberry does best when grown in a cool, moist, but well drained soil. While this soil should be of good quality, if it is very rich in nitrogen the growth may be too rank and in some localities the canes on this account are more liable to winter injury. The best success is usually obtained with a good clay loam, although the raspberry will do fairly well in most kinds of soil. The preparation of the land should be the same as for other bush fruits.

Varieties Recommended

General List Approved by the Board of Control

Black—Hilborn, Older, Gregg, Smith Giant.

Purple—Columbian, Shaffer.

Red—Marlboro, Herbert, Cuthbert.

White—Golden Queen.

District Lists Recommended by the Experimenters

Lake Huron District

A. E. Sherrington
Walkerton, Ont.

Commercial and Domestic—

Black—Hilborn, Conrath, Older.

Purple—Columbian, Shaffer.

Red—Marlboro, Herbert, Cuthbert.

THE STRAWBERRY

The strawberry is the most popular fruit cultivated in Ontario. This is doubtless due in part to the intrinsic value of the strawberry itself, which is one of the most delicious of fruits, but it is believed that the popularity of the strawberry comes largely from the fact that it can be grown by almost every one, as, unlike most fruits, very little land is required to produce sufficient for home consumption.

Strawberries can be grown in all parts of Ontario where the soil is suitable, hence large quantities are produced and consumed annually, and owing to the difference in the time of ripening between the southern and northern parts of the Province, the season is lengthened very much, and furthermore, the strawberries of one district do not come in such close competition with those from another as they would do if all ripened at the same time.

Strawberries will succeed on almost any rich well drained soil, but the largest crops are, it is believed, produced on a friable clay loam which is retentive of moisture. It is important, however, to avoid planting strawberries where water is likely to lie at any time, as surface water is very injurious to strawberries, and if water freezes over strawberries in winter they are almost sure to be killed.

Varieties Recommended

Commercial—Splendid (Perfect), Bederwood (P.), Warfield (Imperfect), not suited to light, sandy soil, Greenville (Imp.), Williams (P.), Saunders (P.), Sample (Imp.), Irene (Imp.), Buster (Imp.).

Domestic—Van Deman (P.), Splendid (P.), Excelsior (P.), Dunlap (P.), Ruby (P.), Bubach (Imp.), Irene (Imp.), Belt (P.), Lovett (P.).

Note—In selecting varieties for planting, perfect-flowered varieties should be included to fertilize those having imperfect flowers.

Nelson Monteith,
Minister of Agriculture.

CANADA FIELD PEA AS A COVER CROP IN THE ROGUE RIVER VALLEY. See *Cover Crops under Apple.*

CANADIAN FRUIT MARKS ACT. See *Laws.*

Candleberry

The candleberry is called also bayberry, candleberry myrtle, tallow tree and wax myrtle (*Myrica cerifera*). The nuts are called candle nuts and, when put into hot water, furnish a greenish colored substance waxy and oily, which, being refined, is made into candles. It grows in the wet soils of North America, near the seashore. The berries intended for making candles are gathered late in autumn. Another plant belonging to the same genus, grows in Scotland, a small shrub growing a little like the myrtle or willow, of a fragrant odor and a bitter taste, and yielding an essential oil by distillation. It was formerly used in the north of Europe instead of hops and in some places is still so used. In Sweden and Wales it is used in dyeing and produces a yellowish color.

GRANVILLE LOWTHER

Canning and Preserving Fruit in the Home

The common fruits, because of their low nutritive value, are not, as a rule, estimated at their real worth as food. Fruit has great dietetic value and should be used generously and wisely, both fresh and cooked. Fruits supply a variety of flavors, sugar, acids, and a necessary waste or bulky material for aiding in intestinal movement. They are generally rich in potash and soda salts and other minerals. Most fresh fruits are cooling and refreshing. The vegetable acids have a solvent power on the nutrients and are an aid to digestion when not taken in excess.

Fruit and fruit juices keep the blood in a healthy condition when the supply of fresh meat, fish, and vegetables is limited and salt or smoked meats constitute the chief elements of diet. Fresh fruit is generally more appetizing and refreshing than cooked. For this reason it is often eaten in too large quantities, and frequently when underripe or overripe; but when of good quality and eaten in moderate quantities it promotes healthy intestinal action and rarely hurts anyone.

If eaten immoderately, uncooked fruit is apt to induce intestinal disturbances. If eaten unripe, it often causes stomach and intestinal irritation; overripe, it has a tendency to ferment in the alimentary canal. Cooking changes the character and flavor of fruit, and while the product is not so cooling and refreshing as in the raw state, it can, as a rule, be eaten with less danger of causing stomach or intestinal trouble. If sugar be added to the cooked fruit, the nutritive value will be increased. A large quantity of sugar spoils the flavor of the fruit and is likely to make it less easily digested.

Nowhere is there greater need of a generous supply of fruit than on the farm, where the diet is apt to be restricted in variety because of the distance from markets. Every farmer should raise a generous supply of the kinds of fruit that can be grown in his locality. Wives and daughters on the farms should find pleasure in serving these fruits in the most healthful and tempting form. There are a large number of simple, dainty desserts that can be prepared with fruit and without much labor. Such desserts should leave the pie as an occasional luxury instead of allowing it to be considered a daily necessity.

In the season when each kind of fruit is plentiful and at its best a generous supply should be canned for the season when both fruit and fresh vegetables are scarce. A great deal of the fruit should be canned with little or no sugar, that it may be as nearly as possible in the condition of fresh fruit. This is the best condition for cooking purposes. A supply of glass jars does cost something, but that item of expense should be charged to future years as, with proper care, the breaking of a jar need be a rare occurrence. If there be an abundance of grapes and small, juicy fruits, plenty of juice should be canned or bottled for refreshing drinks throughout the year. Remember that the fruit and juice are not luxuries, but an addition to the dietary that will mean better health for the members of the family and greater economy in the cost of the table.

Fresh and Preserved Fruit for the Market

If the supply of fruit is greater than the family needs, it may be made a source of income by sending the fresh fruit to the market, if there is one near enough, or by preserving, canning, and making jelly for sale. To make such an enterprise a success the fruit and work must be first class. There is magic in the word "Home-made," when the product appeals to the eye and the palate; but many careless and incompetent people have found to their sorrow that this word has not magic enough to float inferior goods on the market. As a rule large canning and preserving establishments are clean and have the best appliances, and they employ chemists and skilled labor. The home product must be very good to compete with the attractive goods that are sent out from such establishments. Yet for first class home made products there is a market in all large cities. All first class grocers have customers who purchase such goods.

To secure a market, get the names of several first class grocers in some of the large towns. Write to them asking if they would be willing to try a sample of your goods. If the answer is favorable, send samples of the articles you wish to sell. In the box with the fruit inclose a list of the articles sent and the price. Write your name and address clearly. Mail a note and a duplicate list at the time you send the box. Fixing the price of the goods is important. Make it high enough to cover all expenses and give you a fair return for your labor. The expenses will be the fruit, sugar, fuel, jars, glasses, boxes, packing material, wear and tear of utensils, etc., transportation and commission. The commission will probably be 20 per cent of the selling price. It may be that a merchant will find your prices are too high or too low for his trade, or he may wish to purchase the goods outright. In any case it is essential that you estimate the full cost of the product and the value that you place on your labor. You will then be in a position to decide if the prices offered will compensate you for the labor and expense. Do not be tempted for the sake of a little money to deprive your family of the fruit necessary to health and pleasure.

Packing and Shipping

Each jar or jelly glass must be wrapped in several thicknesses of soft paper (newspapers will answer). Make pads of excelsior or hay by spreading a thick layer between the folds of newspapers. Line the bottom and sides of the box with these pads. Pack the fruit in the padded box. Fill all the spaces between the jars with the packing material. If the box is deep and a second layer of fruit is to go in, put thick pasteboard or thin boards over the first layer and set the wrapped jars on this. Fill all the spaces and cover the top with the packing material. Nail on the cover and mark clearly: GLASS. THIS SIDE UP.

The great secret in packing is to fill every particle of space so that nothing can move.

Principles of Canning and Preserving

In the preservation of foods by canning, preserving, etc., the most essential things in the processes are the sterilization of the food and all the utensils and the sealing of the sterilized food to exclude all germs.

Bacteria, Yeasts and Fermentation

Over 100 years ago Francois Appert was the first to make practical application of the method of preserving food by putting it in cans or bottles, which he hermetically sealed. He then put the full bottles or cans in water and boiled them for more or less time, depending upon the kinds of food.

In Appert's time and, indeed, until recent years, it was generally thought that the oxygen of the air caused the decomposition of food. Appert's theory was that the things essential to the preservation of food in this manner were the exclusion of air and the application of gentle heat, as in the water bath, which caused a fusion of the principal constituents and ferments in such a manner that the power of the ferments was destroyed.

The investigations of scientists, particularly of Pasteur, have shown that it is not the oxygen of the air which causes fermentation and putrefaction, but bacteria and other microscopic organisms.

Appert's theory as to the cause of the spoiling of food was incorrect, but his method of preserving it by sealing and cooking was correct, and the world owes him a debt of gratitude.

In their investigations scientists have found that if food is perfectly sterilized and the opening of the jar or bottle plugged with sterilized cotton, food will not ferment, for the bacteria and yeasts to which such changes are due cannot pass through the cotton. This method cannot be conveniently followed with large jars.

Bacteria and yeasts exist in the air, in the soil, and on all vegetable and animal substances, and even in the living body, but although of such universal occurrence, the true knowledge of their nature and economic importance has only been gained during the last 40 years.

There are a great many kinds of these micro-organisms. Some do great harm, but it is thought that the greater part of them are beneficial rather than injurious.

Bacteria are one-celled and so small they can only be seen by aid of a microscope. The process of reproduction is simple and rapid. The bacterium becomes constricted, divides, and finally there are two cells instead of one. Under favorable conditions each cell divides, and so rapid is the work that it has been estimated that one bacterium may give rise, within 24 hours to 17,000,000 of similar organisms. The favorable conditions for growth are moisture, warmth and proper food. Yeasts, which are also one-celled organisms, grow less rapidly. A bud develops, breaks off, and forms a new yeast plant. Some yeasts and some kinds of bacteria produces spores. Spores, like the dried seeds of plants, may retain their vitality for a long time, even when exposed to conditions which kill the parent organism.

Yeasts and nearly all bacteria require oxygen, but there are species of the latter that seem to grow equally well without it, so that the exclusion of air, which, of course, contains oxygen, is not always a protection, if one of the anaerobic bacteria, as the kinds are called which do not require oxygen, is sealed in the can.

Spoiling of food is caused by the development of bacteria or yeasts.

Certain chemical changes are produced as shown by gases, odors and flavors.

Bacteria grow luxuriantly in foods containing a good deal of nitrogenous material, if warmth and moisture are present. Among foods rich in nitrogenous substances are all kinds of meat, fish, eggs, peas, beans, lentils, milk, etc. These foods are difficult to preserve on account of the omnipresent bacteria. This is seen in warm, muggy weather, when fresh meat, fish, soups, milk, etc., spoil quickly. Bacteria do not develop in substances containing a large percentage of sugar, but they grow rapidly in a suitable wet substance which contains a small percentage of sugar. Yeasts grow very readily in dilute solutions containing sugars in addition to some nitrogenous and mineral matters. Fruits are usually slightly acid and in general do not support bacterial growth, and so it comes about that canned fruits are more commonly fermented by yeasts than by bacteria.

Some vegetable foods have so much acid and so little nitrogenous substance that very few bacteria or yeasts attack them. Lemons, cranberries and rhubarb belong to this class.

Temperature is an important factor in the growth of bacteria and yeasts. There are many kinds of these organisms, and each kind grows best at a certain temperature, some at a very low one and others at one as high as 125 degrees Fahrenheit, or more. However, most kinds of bacteria are destroyed if exposed for 10 or 15 minutes to the temperature of boiling water (212 degrees Fahrenheit); but, if the bacteria are spore producers, cooking must be continued for an hour or more to insure their complete destruction. Generally speaking, in order to kill the spores the temperature must be higher than that of boiling water, or the article to be preserved must be cooked for about two hours at a temperature of 212 degrees Fahrenheit, or a shorter time at a higher temperature under pressure. Yeasts and their spores are, however, more easily destroyed by heat than bacteria spores. Hence, fruits containing little nitrogenous material are more easily protected from fermentation than nitrogenous foods in which in general fermentation is caused by bacteria. Of course it is not possible to know what kinds of organisms are in the food one is about to can or bottle; but we do know that most fruits are not favorable to the growth of bacteria, and, as a rule, the yeasts which grow in fruits and fruit juices can be destroyed by cooking 10 or 15 minutes at a temperature of 212 degrees Fahrenheit. If no living organisms are left, and the sterilization of all appliances has been thorough, there is no reason why the fruit, if properly sealed, should not keep, with but slight change of texture or flavor, for a year or longer, although canned fruits undergo gradual change and deterioration even under the most favorable conditions.

When fruit is preserved with a large amount of sugar (a pound of sugar to a pound of fruit) it does not need to be hermetically sealed to protect it from bacteria and yeasts, because the thick, sugary syrup formed is not favorable to their growth. However, the self-sealing jars are much better than keeping such fruit in large receptacles, from which it is taken as needed, because molds grow freely on moist, sugary substances exposed to the air.

Molds and Molding

Every housekeeper is familiar with molds which, under favorable conditions of warmth and moisture, grow upon almost any kind of organic material. This is seen in damp, warm weather, when molds form in a short time on all sorts of starchy foods, such as boiled potatoes, bread, mush, etc., as well as fresh, canned, and preserved fruits.

Molds develop from spores which are always floating about in the air. When a spore falls upon a substance containing moisture and suitable food it sends out a fine thread, which branches and works its way over and into the attacked substance. In a short time spores are produced and the work of reproduction goes on.

In the first stages molds are white or light gray and hardly noticeable; but when spores develop the growth gradually becomes colored. In fact, the conditions of advanced growth might be likened to those of a flower garden. The threads—mycelium—might be likened to the roots of plants and the spores to the flower and seeds.

Mold spores are very light and are blown about by the wind. They are a little heavier than air, and drop on shelves, tables and floor, and are easily set in motion again by the movement of a brush, duster, etc. If one of these spores drops on a jar of preserves or a tumbler of jelly, it will germinate if there be warmth and moisture enough in the storeroom. Molds do not ordinarily cause fermentation of canned foods, although they are the common cause of the decay of raw fruits. They are not as injurious to canned goods as are bacteria and yeasts. They do not penetrate deeply into preserves or jellies, or into liquids or semi-liquids, but if given time they will, at ordinary room temperature, work all through suitable solid substances which contain moisture. Nearly every housekeeper has seen this in the molding of a loaf of bread or cake.

In the work of canning, preserving and jelly making it is important that the food shall be protected from the growth of molds as well as the growth of yeasts and bacteria.

To kill mold spores food must be exposed to a temperature of from 150 degrees Fahrenheit to 212 degrees Fahrenheit. After this it should be kept in a cool, dry place and covered carefully that no floating spore can find lodgment on its surface.

Sterilization

To sterilize a substance or thing is to destroy all life and sources of life in and about it. In following the brief outline of the structure and work of bacteria, yeasts and molds, it has been seen that damage to foods comes through the growth of these organisms on or in the food; also that if such organisms are exposed to a temperature of 212 degrees Fahrenheit, life will be destroyed, but that spores and a few resisting bacteria are not destroyed at a temperature of 212 degrees Fahrenheit unless exposed to it for two or more hours.

Bacteria and yeasts, which are intimately mixed with food, are not as easily destroyed as are those on smooth surfaces, such as the utensils and jars employed in the preparation of the food.

Since air and water, as well as the foods, contain bacteria and yeasts, and may contain mold spores, all utensils used in the process of preserving foods are liable to be contaminated with these organisms. For this reason all appliances, as well as the food, must be sterilized.

Stewpans, spoons, strainers, etc., may be put on the fire in cold or boiling water and boiled 10 or 15 minutes. Tumblers, bottles, glass jars, and covers should be put in cold water and heated gradually to the boiling point, and then boiled for 10 or 15 minutes. The jars must be taken one at a time from the boiling water at the moment they are to be filled with the boiling food. The work should be done in a well-swept and dusted room, and the clothing of the workers and the towels used should be clean.

In canning fruits it is well to remember that the product is more satisfactory if heated gradually to the boiling point and then cooked the given time.

Utensils Needed for Canning and Preserving

In preserving, canning, and jelly-making, iron or tin utensils should never be used. The fruit acids attack these metals and so give a bad color and metallic taste to the products. The preserving kettles should be porcelain lined, enameled, or of a metal that will not form troublesome chemical combinations with fruit juices. The kettles should be broad rather than deep, as the fruit should not be cooked in deep layers. Nearly all the necessary utensils may be found in some ware not subject to chemical action. A list of the most essential articles follows:

Two preserving kettles, one colander, one fine strainer, one skimmer, one ladle, one large-mouthed funnel, one wire frying basket, one wire sieve, four long-handled wooden spoons, one wooden masher, a few large pans, knives for paring fruit (plated if possible), flat-bottomed clothes boiler, wooden or willow rack to put in the bottom of the boiler, iron tripod or ring, squares of cheese cloth. In addition, it would be well to have a flannel straining bag, a frame on which to hang the bag, a syrup gauge and a glass cylinder, a fruit pricker, and plenty of clean towels. The regular kitchen pans will answer for holding and washing the fruit. Mixing bowls and stone crocks can be used for holding the fruit juice and pared fruit. When fruit is to be plunged into boiling water for a few minutes before paring, the ordinary stewpans may be employed for this purpose.

Scales are a desirable article in every kitchen, as weighing is much more accurate than the ordinary measuring. But, knowing that a large percentage of the housekeepers do not possess scales, it has seemed wise to give all the rules in measure rather than weight.

If canning is done by the oven process, a large sheet of asbestos, for the bottom of the oven, will prevent the cracking of jars.

The wooden rack, on which the bottles rest in the washboiler, is made in this manner: Have two strips of wood measuring one inch high, one inch wide, and two inches shorter than the length of the boiler. On these pieces of wood tack thin strips of wood that are one and one-half inches shorter than the width of the boiler. These cross-strips should be about one inch wide, and there should be an inch between two strips. This rack will support the jars and will admit the free circulation of boiling water about them.

Young willow branches, woven into a mat, also make a good bed for bottles and jars.

The wire basket is a saver of time and strength. The fruit to be peeled is put into the basket, which is lowered into a deep kettle partially filled with boiling water. After a few minutes the basket is lifted from the boiling water, plunged for a moment into cold water, and the fruit is ready to have the skin drawn off.

A strong wire sieve is a necessity when purees of fruit are to be made. These sieves are known as puree sieves. They are made of strong wire and in addition have supports of still stronger wire.

A fruit pricker is easily made and saves time. Cut a piece half an inch deep from a broad cork; press through this a dozen or more coarse darning needles; tack the cork on a piece of board. Strike the fruit on the bed of needles, and you have a dozen holes at once. When the work is finished, remove the cork from the board, wash and dry thoroughly. A little oil on the needles will prevent rusting. With needles of the size suggested there is little danger of the points breaking, but it is worth remembering that the use of pricking machines was abandoned in curing prunes on a commercial scale in California because the steel needles broke and remained in the fruit.

A wooden vegetable masher is indispensable when making jellies and purees.

A syrup gauge and glass cylinder are not essential to preserving, canning and jelly making, but they are valuable aids in getting the right proportion of sugar for fruit or jelly. The syrup gauge costs about 50 cents and the cylinder about 25 cents. A lipped cylinder that holds a little over a gill is the best size.

Small iron rings, such as sometimes come off the hub of cart wheels, may be used instead of a tripod for sligntly raising the preserving kettels from the hot stove or range.

To make a flannel straining bag, take a square piece of flannel (27 by 27 inches is a good size), fold it to make a three-cornered bag, stitch one of the sides, cut the top square across, bind the opening with strong, broad tape, stitch on this binding four tapes with which to tie the bag to a frame.

To use this bag, tie it to a strong frame or to the backs of two kitchen chairs. If the chairs are used, place some heavy articles in them; or the bag may hang on a pole (a broom handle) which rests on the backs of the chairs. A high stool turned upside down makes a good support for the bag. Put a bowl on the floor under the bag, then pour in the fruit juice, which will pass through comparatively clear. Before it is used the bag should be washed and boiled in clear water.

Selection and Preparation of the Fruit

The selection of fruit is one of the first steps in obtaining successful results. The flavor of fruit is not developed until it is fully ripe, but the time at which the fruit is at its best for canning, jelly making, etc., is just before it is perfectly ripe. In all soft fruits the fermentative stage follows closely upon the perfectly ripe stage; therefore it is better to use underripe rather than overripe fruit. This is especially important in jelly making for another reason also: In overripe fruit the pectin begins to lose its jelly-making quality.

All fruits should, if possible, be freshly picked for preserving, canning, and jelly making. No imperfect fruit should be canned or preserved. Gnarly fruit may be used for jellies or marmalades by cutting out defective portions. Bruised spots should be cut out of peaches and pears. In selecting small-seeded fruits, like berries, for canning, those having a small proportion of seed to pulp should be chosen. In dry seasons berries have a larger proportion of seeds to pulp than in wet or normal seasons, and it is not wise to can or preserve such fruit unless the seeds are removed. The fruit should be rubbed through a sieve that is fine enough to keep back the seeds. The strained pulp can be preserved as a puree or marmalade. When fruit is brought into the house put it where it will keep cool and crisp until you are ready to use it.

The preparation of fruit for the various processes of preserving is the second important step. System will do much to lighten the work. Begin by having the kitchen swept and dusted thoroughly, that there need not be a large number of mold spores floating about. Dust with a damp cloth. Have plenty of hot water and pans in which jars and utensils may be sterilized. Have at hand all necessary utensils, towels, sugar, etc. Prepare only as much fruit as can be cooked while it still retains its color and crispness. Before beginning to pare fruit have some syrup ready, if that is to be used, or if sugar is to be added to the fruit have it weighed and measured.

Decide upon the amount of fruit you will cook at one time, then have two bowls—one for sugar and one for the fruit—that will hold just the quantity of each. As the fruit is pared or hulled, as the case may be, drop it into its measuring bowl. When the measure is full put the fruit and sugar in the preserving kettle. While this is cooking another measure may be prepared and put in the second preserving kettle. In this way the fruit is cooked quickly and put in the jars and sealed at once, leaving the pans ready to sterilize another set of jars.

If the fruit is to be preserved or canned with syrup, it may be put into the jars as fast as it is prepared. As soon as a jar is full, pour in enough syrup to cover it.

If several people are helping and large kettles are being used for the preserving, or where fruit (like quinces and hard pears) must be first boiled in clear water, the pared fruit should be dropped into a bowl of cold water made slightly acid with lemon juice (one tablespoonful of lemon juice to a quart of water). This will keep the fruit white.

All large, hard fruit must be washed before paring. Quinces should be rubbed with a coarse towel before they are washed. If berries must be washed, do the work before stemming or hulling them. The best way to wash berries is to put a small quantity into a colander and pour cold water over them; then turn them on a sieve to drain. All this work must be done quickly that the fruit may not absorb much water. Do not use the fingers for hulling strawberries. A simple huller can be bought for five cents.

If practicable pare fruit with a silver knife, so as not to stain or darken the product. The quickest and easiest way to peel peaches is to drop them into boiling water for a few minutes. Have a deep kettle a little more than half-full of boiling water; fill a wire basket with peaches; put a long-handled spoon under the handle of the basket and lower into the boiling water. Let the peaches drain a minute, then peel. Plums and tomatoes may be peeled in the same manner.

If the peaches are to be canned in syrup, put them at once into the sterilized jars. They may be canned whole or in halves. If in halves, remove nearly all the stones or pits. For the sake of the flavor, a few stones should be put in each jar.

When preparing cherries, plums, or crabapples for canning or preserving, the stem or a part of it may be left on the fruit.

When preparing to make jelly have ready the cheesecloth strainer, enameled colander, wooden spoons, vegetable masher, measures, tumblers, preserving kettles, and sugar.

If currant jelly is to be made, free the fruit from leaves and large stems. If the jelly is to be made from any of the other small fruits, the stems and hulls must be removed.

When the jelly is to be made from any of the larger fruits the important part of the preparation is to have the fruit washed clean, then to remove the stem and blossom end. Nearly all the large fruits are better for having the skin left on. Apples and pears need not be cored. There is so much gummy substance in the cores of quinces that it is best not to use this portion in making fine jelly.

Making Syrup for Use in Canning and Preserving

Such syrups as are used in canning and preserving are made with varying proportions of water and sugar. When the proportion of sugar is large and that of

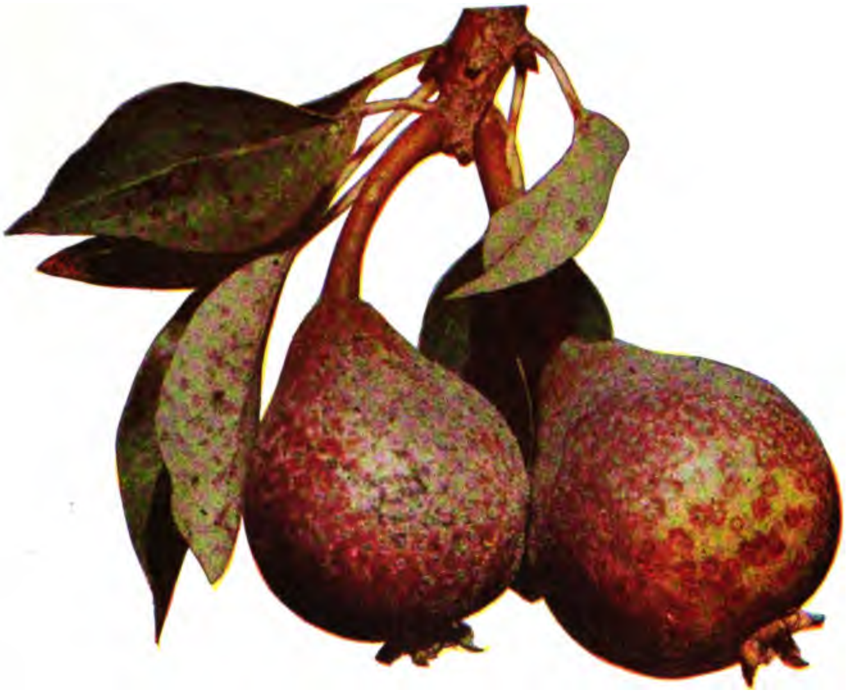

PLATE V

The San Jose Scale on Pears.

(See page 537.)

the water small the syrup is said to be heavy. When the water predominates the syrup is light.

There are several methods of measusing the proportion of sugar in a syrup. The most scientific and accurate is with the syrup gauge. Careful measurement or weighing is, however, quite satisfactory for all ordinary work if the syrup need not be boiled a long time. In boiling the water evaporates and the syrup grows thicker and richer. The amount of evaporation depends upon the surface exposed and the pressure of the atmosphere. For example, if a large quantity of syrup is boiled in a deep kettle the evaporation will not be rapid. If the same quantity of syrup were boiled the same length of time in a high altitude, Colorado for example, and at the sea level, it would be found that the syrup boiled at the sea level would be thicker and less in volume than that boiled in Colorado. From this it will be seen that it is difficult to say what proportion of sugar a syrup will contain after it has been boiling 10 or more minutes. Of course by the use of the syrup gauge the proportion of sugar in a syrup may be ascertained at any stage of the boiling. After all, however, it is possible to measure sugar and water so that you can know the percentage of sugar when the syrup begins to boil. The following statement gives the percentage of sugar at the time when the syrup has been boiling one minute and also what kind of syrup is suitable for the various kinds of fruit:

One pint sugar and one gill of water gives syrup of 40 degrees density: Use for preserved strawberries and cherries.

One pint sugar and one-half pint water gives syrup of 32 degrees density.

One pint sugar and three gills water gives syrup of 28 degrees density: Use either this or the preceding for preserved peaches, plums, quinces, currants, etc.

One pint sugar and one pint water gives syrup of 24 degrees density: Use for canned acid fruits.

One pint sugar and one and one-half pints water gives syrup of 17 degrees density.

One pint sugar and two pints water gives syrup of 14 degrees density: Use either of these two light syrups for canned pears, peaches, sweet plums, and cherries, raspberries, blueberries, and blackberries.

The lightest syrups may be used for filling up the jars after they are taken from the oven or boiler. The process of making syrup is very simple, but there are a few points that must be observed if syrup and fruit are to be perfect. Put the sugar and water in the saucepan and stir on the stove until all the sugar is dissolved. Heat slowly to the boiling point and boil gently without stirring. The length of time that the syrup should boil will depend upon how rich it is to be. All syrups are better for boiling from 10 to 30 minutes. If rich syrups are boiled hard, jarred, or stirred, they are apt to crystallize. The syrup may be made a day or two in advance of canning time. The light syrups will not keep long unless sealed, the heavy syrups keep well if covered well.

Use of Syrup Gauge

The syrup gauge is a graduated glass tube, with a weighted bulb, that registers from no degrees to 50 degrees, and that is employed to determine the quantity of sugar contained in a syrup.

If this gauge is placed in pure water the bulb will rest on the bottom of the cylinder or other container. If sugar be dissolved in the water the gauge will begin to float. The more sugar there is dissolved in the water the higher the gauge will rise. In making tests it is essential that the syrup should be deep enough to reach the zero point of the gauge. If a glass cylinder holding about half a gill is filled to about two-thirds its height, and the gauge is then placed in the cylinder, the quantity of sugar in the syrup will be registered on the gauge.

Experiments have demonstrated that when sugar is dissolved and heated in fruit juice, if the syrup gauge registers 25 degrees, the proportion of sugar is exactly right for combining with the pectin bodies to make jelly. The syrup gauge and the glass cylinder must both be heated gradually that the hot syrup may not break them. If the gauge registers more than 25 degrees, add more fruit juice. If, on the other hand, it registers less than 25 degrees, add more sugar. In making syrups for canning and preserving fruits, the exact amount of sugar in a syrup may be ascertained at any stage of boiling, and the syrup be made heavier by adding sugar, or lighter by adding water, as the case demands.

Canning Fruit

This method of preserving fruit for home use is, from all points, the most desirable. It is the easiest and commonly considered the most economical and the best, because the fruit is kept in a soft and juicy condition in which it is believed to be easily digested. The wise housekeeper will can her principal fruit supply, making only enough rich preserves to serve for variety and for special occasions.

The success of canning depends upon absolute sterilization. If the proper care is exercised there need be no failure, except in rare cases, when a spore has developed in the can. There are several methods of canning; and while the principle is the same in all methods, the conditions under which the housekeeper must do her work may, in her case, make one method more convenient than another. For this reason three will be given which are considered the best and easiest. These are: Cooking the fruit in the jars in an oven; cooking the fruit in the jars in boiling water; and stewing the fruit before it is put in the jars. The quantity of sugar may be increased if the fruit is liked sweet.

It is most important that the jars, covers, and rubber rings be in perfect condition. Examine each jar and cover to see that there is no defect in it. Use only fresh rubber rings, for if the rubber is not soft and elastic the sealing will not be perfect. Each year numbers of jars of fruit are lost because of the false economy in using an old ring that has lost its softness and elasticity. Having the jars, covers, and rings in perfect condition, the next thing is to wash and sterilize them.

Have two pans partially filled with cold water. Put some jars in one, laying them on their sides, and some covers in the other. Place the pans on the stove where the water will heat to the boiling point. The water should boil at least 10 or 15 minutes. Have on the stove a shallow milkpan in which there is about two inches of boiling water. Sterilize the cups, spoons and funnel, if you use one, by immersing in boiling water for a few minutes. When ready to put the prepared fruit in the jars slip a broad skimmer under a jar and lift it and drain free of water. Set the jar in the shallow milk pan and fill to overflowing with the boiling fruit. Slip a silver-plated knife or the handle of a spoon around the inside of the jar, that the fruit and juice may be packed solidly. Wipe the rim of the jar, dip the rubber ring in boiling water and put it smoothly on the jar, then put on the cover and fasten. Place the jar on a board and out of a draft of cold air. The work of filling and sealing must be done rapidly, and the fruit must be boiling hot when it is put into the jars. If screw covers are used, it will be necessary to tighten them after the glass has cooled and contracted. When the fruit is cold wipe the jars with a wet cloth. Paste on the labels, if any, and put the jars on shelves in a cool, dark closet.

In canning, any proportion of sugar may be used, or fruit may be canned without the addition of any sugar. However, that which is designed to be served as a sauce should have the sugar cooked with it. Fruit intended for cooking purposes need not have the sugar added to it.

Juicy fruits, such as berries and cherries, require little or no water. Strawberries are better not to have water added to them. The only exception to this is when they are cooked in a heavy syrup.

Raspberries

12 quarts of raspberries.
2 quarts of sugar.

Put two quarts of the fruit in the preserving kettle; heat slowly on the stove;

crush with a wooden vegetable masher; spread a square of cheesecloth over a bowl, and turn the crushed berries and juice into it. Press out the juice, which turn into the preserving kettle. Add the sugar and put on the stove; stir until the sugar is dissolved. When the syrup begins to boil, add the remaining 10 quarts of berries. Let them heat slowly. Boil 10 minutes, counting from the time they begin to bubble. Skim well while boiling. Put in cans and seal as directed.

Raspberries and Currants

10 quarts of raspberries.
3 quarts of currants.
2½ quarts of sugar.

Heat, crush, and press the juice from the currants and proceed as directed for raspberries.

Blackberries

The same as for raspberries.

Currants

12 quarts of currants.
4 quarts of sugar.

Treat the same as for raspberries.

Gooseberries

6 quarts of berries.
1½ quarts of sugar.
1 pint of water.

For green gooseberries dissolve the sugar in the water, then add the fruit and cook 15 minutes. Ripe gooseberries are to be treated the same as the green fruit, but use only half as much water. Green gooseberries may also be canned the same as rhubarb. (See *Rhubarb.*)

Blueberries

12 quarts of berries.
1 quart of sugar.
1 pint of water.

Put water, berries and sugar in the preserving kettle; heat slowly. Boil 15 minutes, counting from the time the contents of the kettle begin to bubble.

Cherries

6 quarts of cherries.
1½ quarts of sugar.
½ pint of water.

Measure the cherries after the stems have been removed. Stone them or not, as you please. If you stone them, be careful to save all the juice. Put the sugar and water in the preserving kettle and stir over the fire until the sugar is dissolved. Put in the cherries and heat slowly to the boiling point. Boil 10 minutes, skimming carefully.

Grapes

6 quarts of grapes.
1 quart of sugar.
1 gill of water.

Squeeze the pulp of the grapes out of the skins. Cook the pulp five minutes and then rub through a sieve that is fine enough to hold back the seeds. Put the water, skins and pulp into the preserving kettle and heat slowly to the boiling point. Skim the fruit and then add the sugar. Boil 15 minutes.

Sweet grapes may be canned with less sugar; very sour ones may have more.

Rhubarb

Cut the rhubarb when it is young and tender. Wash it thoroughly and then pare; cut into pieces about two inches long. Pack in sterilized jars. Fill the jars to overflowing with cold water and let them stand 10 minutes. Drain off the water and fill again to overflowing with fresh cold water. Seal with sterilized rings and covers. When required for use, treat the same as fresh rhubarb. Green gooseberries may be canned in the same manner. Rhubarb may be cooked and canned with sugar in the same manner as gooseberries.

Peaches

8 quarts of peaches.
1 quart of sugar.
3 quarts of water.

Put the sugar and water together and stir over the fire until the sugar is dissolved. When the syrup boils, skim it. Draw the kettle back where the syrup will keep hot but not boil.

Pare the peaches, cut in halves, and remove the stones, unless you prefer to can the fruit whole.

Put a layer of the prepared fruit into the preserving kettle and cover with some of the hot syrup. When the fruit begins to boil, skim carefully. Boil gently for 10 minutes, then put in the jars and seal. If the fruit is not entirely ripe, it may require a little longer time to cook. It should be so tender that it may be pierced easily with a silver fork. It is best to put only one layer of fruit in the preserving kettle. While this is cooking the fruit for the next batch may be pared.

Pears

If the fruit is ripe it may be treated exactly the same as peaches. If, on the other hand, it is rather hard it must be cooked until so tender that a silver fork will pierce it readily.

Quinces

4 quarts of pared, cored and quartered quinces.
1½ quarts of sugar.
2 quarts of water.

Rub the fruit hard with a coarse, crash towel, then wash and drain. Pare, quarter, and core; drop the pieces into cold water (See *Selection and Preparation of the Fruit*—paragraph *re Quinces and Pears*). Put the fruit in the preserving kettle with cold water to cover it generously. Heat slowly and simmer gently until tender. The pieces will not all require the same time to cook. Take each piece up as soon as it is so tender that a silver fork will pierce it readily. Drain on a platter. Strain the water in which the fruit was cooked throu h cheesecloth. Put two quarts of the strained liquid and the sugar into the preserving kettle; stir over the fire until the sugar is dissolved. When it boils skim well and put in the cooked fruit. Boil gently for about 20 minutes.

Crab Apples

6 quarts of apples.
1½ quarts of sugar.
2 quarts of water.

Put the sugar and water into the preserving kettle. Stir over the fire until the sugar is dissolved. When syrup boils skim it.

Wash the fruit, rubbing the blossom end well. Put it in the boiling syrup, and cook gently until tender. It will take from 20 to 50 minutes, depending upon the kind of crab apples.

Plums

8 quarts of plums.
2 quarts of sugar.
1 pint of water.

Nearly all kinds of plums can be cooked with the skins on. If it is desired to remove the skin of any variety, plunge them in boiling water for a few minutes. When the skins are left on, prick them thoroughly to prevent bursting.

Put the sugar and water into the preserving kettle and stir over the fire until the sugar is dissolved. Wash and drain the plums. Put some of the fruit in the boiling syrup. Do not crowd it. Cook five minutes; fill and seal the jars. Put more fruit in the syrup. Continue in this manner until all the fruit is done. It may be that there will not be sufficient syrup toward the latter part of the work; for this reason it is well to have a little extra syrup on the back of the stove.

Stewed Tomatoes

Wash the tomatoes and plunge into boiling water for five minutes. Pare and slice, and then put into the preserving kettle; set the kettle on an iron ring. Heat the tomatoes slowly, stirring frequently from the bottom. Boil for 30 minutes, counting from the time the vegetable begins actually to boil. Put in sterilized jars and seal.

Whole Tomatoes

6 quarts of medium-sized tomatoes.
4 quarts of sliced tomatoes.

Put the pared and sliced tomatoes into a stewpan and cook as directed for stewed tomatoes. When they have been boiling 20 minutes take from the fire and rub through a strainer. Return to the fire.

While the sliced tomatoes are cooking, pare the whole tomatoes and put them in sterilized jars. Pour into the jars enough of the stewed and strained tomato to fill all the interstices. Put the uncovered jars in a moderate oven, placing them on a pad of asbestos or in shallow pans of hot water. Let the vegetable cook in the oven for half an hour. Take from the oven and fill to overflowing with boiling hot, strained tomato, then seal. If there is any of the strained tomato left, can it for sauces.

Canned Fruit Cooked in the Oven

This method of canning fruit, in the opinion of the writer, is the one to be preferred. The work is easily and quickly done, and the fruit retains its shape, color, and flavor better than when cooked in the preserving kettle. Cover the bottom of the oven with a sheet of asbestos, the kind plumbers employ covering pipes. It is very cheap and may usually be found at plumbers' shops. If the asbestos is not available, put into the oven shallow pans in which there are about two inches of boiling water. Sterilize the jars and utensils. Make the syrup; prepare the fruit the same as for cooking in the preserving kettle. Fill the hot jars with it, and pour in enough syrup to fill the jar solidly. Run the blade of a silver-plated knife around the inside of the jar. Place the jars in the oven, either on the asbestos or in the pan of water. The oven should be moderately hot. Cook the fruit ten minutes; remove from the oven and fill the jar with boiling syrup. Wipe and seal. Place the jars on a board and out of a draft of air. If the screw covers are used tighten them after the glass has cooled.

Large fruits, such as peaches, pears, quinces, crab apples, etc., will require about a pint of syrup to each quart jar of fruit. The small fruit will require a little over half a pint of syrup.

The amount of sugar in each quart of syrup should be regulated to suit the fruit with which it is to be used.

Canned Fruit Cooked in a Water Bath

Prepare the fruit and syrup as for cooking in the oven.

Fill the sterilized jars and put the covers on loosely. Have a wooden rack in the bottom of a wash boiler. Put in enough warm water to come to about 4 inches above the rack. Place the filled jars in the boiler, but do not let them touch one another. Pack clean white cotton rags, or perhaps better, cotton rope, between and around the jars to prevent them from striking one another when the water begins to boil. Cover the boiler and let the fruit cook ten minutes from the time the water surrounding it begins to boil.

Draw the boiler back and take off the cover. When the steam passes off take out one jar at a time and place in a pan of boiling water beside the boiler, fill up with boiling syrup and seal. Put the jars on a board and do not let cold air blow upon them. If screw covers are used tighten them when the glass has cooled and contracted.

Preserving Fruit

In the case of most fruits, canning with a little sugar is to be preferred to preserving with a large quantity of sugar. There are, however, some fruits that are only good when preserved with a good deal of sugar. Of course, such preparations of fruit are only desirable for occasional use. The fruits best adapted for preserving are strawberries, sour cherries, sour plums, and quinces. Such rich preparations should be put up in small jars or tumblers.

Strawberries

Use equal weights of sugar and strawberries. Put the strawberries in the preserving kettle in layers, sprinkling sugar over each layer. The fruit and sugar should not be more than 4 inches deep. Place the kettle on the stove and heat the fruit and sugar slowly to the boiling point. When it begins to boil skim carefully. Boil ten minutes, counting from the time the fruit begins to bubble. Pour the cooked fruit into platters, having it about 2 or 3 inches deep. Place the platters in a sunny window, in an unused room, for three or four days. In that time the fruit will grow plump and firm, and the syrup will thicken almost to a jelly. Put this preserve, cold, into jars or tumblers.

White Currants

Select large, firm fruit, remove the stems, and proceed as for strawberries.

Cherries

The sour cherries, such as Early Richmond and Montmorency, are best for this preserve. Remove the stems and stones from the cherries and proceed as for strawberry preserve.

Cherries Preserved with Currant Juice

12 quarts of cherries
3 quarts of currants
2 quarts of sugar

Put the currants in the preserving kettle and on the fire. When they boil up crush them and strain through cheesecloth, pressing out all the juice. Stem and stone the cherries, being careful to save all the juice. Put the cherries, fruit juice, and sugar in the preserving kettle. Heat to the boiling point and skim carefully. Boil for twenty minutes. Put in sterilized jars or tumblers. This gives an acid preserve. The sugar may be doubled if richer preserves are desired.

Plum Preserve

4 quarts of green gages.
2 quarts of sugar.
1 pint of water.

Prick the fruit and put it in a preserving kettle. Cover generously with cold water. Heat to the boiling point and boil gently for five minutes. Drain well.

Put the sugar and water in a preserving kettle and stir over the fire until the sugar is dissolved. Boil five minutes, skimming well. Put the drained green gages in this syrup and cook gently for twenty minutes. Put in sterilized jars.

Other plums may be preserved in the same manner. The skins should be removed from white plums.

Quinces

4 quarts of pared, quartered, and cored quinces.
2 quarts of sugar.
1 quart of water.

Boil the fruit in clear water until it is tender, then skim out and drain. Put the 2 quarts of sugar and 1 quart of water in the preserving kettle; stir until the sugar is dissolved. Let it heat slowly to the boiling point. Skim well and boil for twenty minutes. Pour one-half of the syrup into a second kettle. Put one-half of the cooked and drained fruit into each kettle. Simmer gently for half an hour, then put in sterilized jars. The water in which the fruit was boiled can be used with parings, cores, and gnarly fruit to make jelly.

Fruit Purees

Purees of fruit are in the nature of marmalades, but they are not cooked so long, and so retain more of the natural flavor of the fruit. This is a particularly nice way to preserve the small, seedy fruits, which are to be used in puddings, cake, and frozen desserts.

Free the fruit from leaves, stems, and decayed portions. Peaches and plums should have the skins and stones removed. Rub the fruit through a puree sieve. To each quart of the strained fruit add a pint of sugar. Pack in sterilized jars. Put the covers loosely on the jars. Place the jars on the rack in the boiler. Pour in enough cold water to come half way up the sides of the jars. Heat gradually to the boiling point and boil thirty minutes, counting from the time when the water begins to bubble. Have some boiling syrup ready. As each jar is taken from the boiler put it in a pan of hot water and fill up with the hot syrup. Seal at once.

Marmalades

Marmalades require great care while cooking because no moisture is added to the fruit and sugar. If the marmalade is made from berries the fruit should be rubbed through a sieve to remove the seeds. If large fruit is used have it washed, pared, cored, and quartered.

Measure the fruit and sugar, allowing one pint of sugar to each quart of fruit.

Rinse the preserving kettle with cold water that there may be a slight coat of moisture on the sides and bottom. Put alternate layers of fruit and sugar in the kettle, having the first layer fruit. Heat slowly, stirring frequently. While stirring, break up the fruit as much as possible. Cook about two hours, then put in small sterilized jars.

Fruit Preserved in Grape Juice

Any kind of fruit can be preserved by this method, but it is particularly good for apples, pears, and sweet plums. No sugar need be used in this process.

Boil 6 quarts of grape juice in an open preserving kettle, until it is reduced to 4 quarts. Have the fruit washed and pared, and, if apples or pears, quartered and cored. Put the prepared fruit in a preserving kettle and cover generously with the boiled grape juice. Boil gently until the fruit is clear and tender, then put in sterilized jars.

Boiled Cider

When the apple crop is abundant and a large quantity of cider is made, the housekeeper will find it to her advantage to put up a generous supply of boiled cider. Such cider greatly improves mince-meat, and can be used at any time of the year to make cider apple sauce. It is also a good selling article.

The cider for boiling must be perfectly fresh and sweet. Put it in a large, open preserving kettle and boil until it is reduced one-half. Skim frequently while boiling. Do not have the kettle more than two-thirds full.

Put in bottles or stone jugs.

Cider Apple Sauce

5 quarts of boiled cider.

8 quarts of pared, quartered, and cored sweet apples.

Put the fruit in a large preserving kettle and cover with the boiled cider. Cook slowly until the apples are clear and tender. To prevent burning, place the kettle on an iron tripod or ring. It will require from two to three hours to cook the apples. If you find it necessary to stir the sauce be careful to break the apples as little as possible. When the sauce is cooked, put in sterilized jars.

In the late spring, when cooking apples have lost much of their flavor and acidity, an appetizing sauce may be made by stewing them with diluted boiled cider, using 1 cupful of cider to 3 of water.

Cider Pear Sauce

Cooking pears may be preserved in boiled cider the same as sweet apples. If one prefers the sauce less sour, 1 pint of sugar may be added to each quart of boiled cider.

Methods of Making Jelly

In no department of preserving does the housekeeper feel less sure of the result than in jelly making. The rule that works perfectly one time fails another time. Why this is so the average housekeeper does not know; so there is nearly always an element of uncertainty as to the result of the work. These two questions are being constantly asked: "Why does not my jelly harden?" "What causes my jelly to candy?"

It is an easy matter to say that there is something in the condition of the fruit, or that the fruit juice and sugar were cooked too short or too long a time. These explanations are often true; but they do not help the inquirer, since at other times just that proportion of sugar and time of cooking have given perfect jelly. In the following pages an attempt is made to give a clear explanation of the principles underlying the process of jelly making. It is believed that the women who study this carefully will find the key to unvarying success in this branch of preserving.

Pectin, Pectose, Pectase

In all fruits, when ripe or nearly so, there is found pectin, a carbohydrate somewhat similar in its properties to starch. It is because of this substance in the fruit juice that we are able to make jelly. When equal quantities of sugar and fruit juice are combined and the mixture is heated to the boiling point for a short time, the pectin in the fruit gelatinizes the mass.

It is important that the jelly maker should understand when this gelatinizing agent is at its best. Pectose and pectase always exist in the unripe fruit. As the fruit ripens the pectase acts upon the pectose, which is insoluble in water, converting it into pectin, which is soluble. Pectin is at its best when the fruit is just ripe or a little before. If the juice ferments, or the cooking of the jelly is continued too long, the pectin undergoes a change and loses its power of gelatinizing. It is, therefore, of the greatest importance that the fruit should be fresh, just ripe or a little underripe, and that the boiling of the sugar and juice should not be continued too long.

Fruits vary as to the quantities of sugar, acid, pectin, and gums in their composition. Some of the sour fruits contain more sugar than do some of the milder-flavored fruits. Currants, for example, often contain four or five times as much sugar as the peach. The peach does not contain so much free acid and it does contain a great deal of pectin bodies, which mask the acid; hence, the comparative sweetness of the ripe fruit.

Selection and Handling of Fruit for Jelly Making

An acid fruit is the most suitable for jelly making, though in some of the acid fruits, the strawberry, for example, the quantity of the jelly-making pectin is so small that it is difficult to make jelly with this fruit. If, however, some currant juice be added to the strawberry juice, a pleasant jelly will be the result; yet, of course, the flavor of the strawberry will be modified. Here is a list of the most desirable fruits for jelly making. The very best are given first: Currant, crab apple, apple, quince, grape, blackberry, raspberry, peach.

Apples make a very mild jelly, and it may be flavored with fruits, flowers, or spices. If the apples are acid it is not advisable to use any flavor. Juicy fruits, such as currants, raspberries, etc., should not be gathered after a rain, for they will have absorbed so much water as to make it difficult, without excessive boiling, to get the juice to jelly. If berries are sandy or dusty it will be necessary to wash them, but the work should be done very quickly so that the fruit may not absorb much water.

Large fruits, such as apples, peaches, and pears, must be boiled in water until soft. The strained liquid will contain the flavoring matter and pectin.

It requires more work and skill to make jellies from the fruits to which water must be added than from the juicy fruits. If the juicy fruits are gathered at the proper time one may be nearly sure that they contain the right proportion of water. If gathered after a rain the fruit must be boiled a little longer than the superfluous water may pass off in steam. In the case of the large fruits a fair estimate is 3 quarts of strained juice from 8 quarts of fruit and about 4 quarts of water. If the quantity of juice is greater than this it should be boiled down to 3 quarts. Apples will always require 4 quarts of water to 8 quarts of fruit, but juicy peaches and plums require only 3 or 3½ quarts.

The jelly will be clearer and finer if the fruit is simmered gently and not stirred during cooking.

It is always best to strain the juice first through cheesecloth and without pressure. If the cloth is double the juice will be quite clear. When a very clear jelly is desired the strained juice should pass through a flannel or felt bag. The juice may be pressed from the fruit left in the strainer and used in marmalade or for second-quality jelly.

To make jelly that will not crystallize (candy) the right proportion of sugar must be added to the fruit juice. If the fruit contains a high percentage of sugar, the quantity of added sugar should be a little less than the quantity of fruit juice. That is to say, in a season when there has been a great deal of heat and sunshine there will be more sugar in the fruit than in a cold, wet season; consequently, 1 pint of currant juice will require but three-quarters of a pint of sugar. But in a cold, wet season the pint of sugar for the pint of juice must be measured generously.

Another cause of the jelly crystallizing is hard boiling. When the syrup boils so rapidly that particles of it are thrown on the upper part of the sides of the preserving kettle they often form crystals. If these crystals are stirred into the syrup they are apt to cause the mass to crystallize in time.

The use of the syrup gauge and care not to boil the syrup too violently would do away with all uncertainty in jelly making. The syrup gauge should register 25 degrees, no matter what kind of fruit is used. Jellies should be covered closely and kept in a cool, dry, dark place.

Currant Jelly

The simplest method of making currant jelly is perhaps the following: Free the currants from leaves and large stems. Put them in the preserving kettle; crush a few with a wooden vegetable masher or spoon; heat slowly, stirring frequently.

When the currants are hot, crush them with the vegetable masher. Put a hair sieve or strainer over a large bowl; over this spread a double square of cheesecloth. Turn the crushed fruit and juice into the cheesecloth, and let it drain as long as it drips, but do not use pressure. To hasten the process take the corners of the straining cloth firmly in the hands and lift from the sieve; move the contents by raising one side of the cloth and then the other. After this put the cloth over another bowl. Twist the ends together and press out as much juice as possible. This juice may be used to make a second quality of jelly.

The clear juice may be made into jelly at once, or it may be strained through a flannel bag. In any case, the method of making the jelly is the same.

Measure the juice, and put it in a clean preserving kettle. For every pint of juice add a pint of granulated sugar.

Stir until the sugar is dissolved, then place over the fire; watch closely, and when it boils up draw it back and skim; put over the fire again, and boil and skim once more; boil and skim a third time; then pour into hot glasses taken from the pan of water on the stove and set on a board. Place the board near a sunny window in a room where there is no dust. It is a great protection and advantage to have sheets of glass to lay on top of the tumblers. As soon as the jelly is set cover by one of the three methods given under "Covering Jellies."

To make very transparent currant jelly, heat, crush, and strain the currants as directed in the simplest process. Put the strained juice in the flannel bag and let it drain through. Measure the juice and sugar, pint for pint, and finish as directed above.

To make currant jelly by the cold process follow the first rule for jelly as far as dissolving the sugar in the strained juice. Fill warm, sterilized glasses with this. Place the glasses on a board and put the board by a sunny window. Cover with sheets of glass and keep by the window until the jelly is set. The jelly will be more transparent if the juice is strained through the flannel bag. Jelly made by the cold process is more delicate than that made by boiling, but it does not keep quite so well.

Raspberry and Currant Jelly

Make the same as currant jelly, using half currants and half raspberries.

Raspberry Jelly

Make the same as currant jelly.

Blackberry Jelly

Make the same as currant jelly.

Strawberry Jelly

To 10 quarts of strawberries add 2 quarts of currants and proceed as for currant jelly, but boil fifteen minutes.

Ripe Grape Jelly

An acid grape is best for this jelly. The sweet, ripe grapes contain too much sugar. Half-ripe fruit, or equal portions of nearly ripe and green grapes, will also be found satisfactory. Wild grapes make delicious jelly. Make the same as currant jelly.

Green Grape Jelly

Make the same as apple jelly.

Plum Jelly

Use an underripe acid plum. Wash the fruit and remove the stems. Put into the preserving kettle with 1 quart of water for each peck of fruit. Cook gently until the plums are boiled to pieces. Strain the juice and proceed the same as for currant jelly.

Apple Jelly

Wash, stem, and wipe the apples, being careful to clean the blossom end thoroughly. Cut into quarters and put into the preserving kettle. Barely cover with cold water (about 4 quarts to 8 of apples) and cook gently until the apples are soft and clear. Strain the juice and proceed as for currant jelly. There should be but 3 quarts of juice from 8 quarts of apples and 4 of water.

Apples vary in the percentage of sugar and acid they contain. A fine-flavored acid apple should be employed when possible. Apple jelly may be made at any time of the year, but winter apples are best and should be used when in their prime, i. e., from the fall to December or January. When it is found necessary to make apple jelly in the spring, add the juice of one lemon to every pint of apple juice.

Cider Apple Jelly

Make the same as plain apple jelly, but covering the apples with cider instead of water. The cider must be fresh from the press.

Crab Apple Jelly

Make the same as plain apple jelly.

Quince Jelly

Rub the quinces with a coarse crash towel; cut out the blossom end. Wash the fruit and pare it and cut in quarters. Cut out the cores, putting them in a dish by themselves. Have a large bowl half full of water; drop the perfect pieces of fruit into this bowl. Put the parings and imperfect parts, cut very fine, into the preserving kettle. Add a quart of water to every 2 quarts of fruit and parings. Put on the fire and cook gently for two hours. Strain and finish the same as apple jelly. The perfect fruit may be preserved or canned.

To make quince jelly of a second quality, when the parings and fruit are put on to cook put the cores into another kettle and cover them generously with water and cook two hours. After all the juice has been drained from the parings and fruit, put what remains into the preserving kettle with the cores. Mix well and turn into the straining cloth. Press all the juice possible from this mixture. Put the juice in the preserving kettle with a pint of sugar to a pint of juice; boil ten minutes.

Wild Fruits for Jellies

Wild raspberries, blackberries, barberries, grapes, and beach plums all make delicious jellies. The frequent failures in making barberry jelly come from the fruit not being fresh or from being overripe.

Preparation of the Glasses for Jelly

Sterilize the glasses; take from the boiling water and set them in a shallow baking pan in which there is about 2 inches of boiling water.

Covering Jellies

Jellies are so rich in sugar that they are protected from bacteria and yeasts, but they must be covered carefully to protect them from mold spores and evaporation. The following methods of covering jellies are good:

Have disks of thick white paper the size of the top of the glass. When the jelly is set, brush the top over with brandy or alcohol. Dip the disk of paper in the spirits and put it on the jelly. If the glasses have covers, put them on. If there are no covers, cut disks of paper about half an inch in diameter larger than the top of the glass. Beat together the white of one egg and a tablespoonful of cold water. Wet the paper covers with this mixture and put over the glass, pressing down the sides well to make them stick to the glass; or the covers may be dipped in olive oil and tied on the glasses, but they must be cut a little larger than when the white of egg is used.

A thick coating of paraffin makes a good cover, but not quite so safe as the paper dipped in brandy or alcohol, because the spirits destroy any mold or spores that may happen to rest on the jelly. If such spores are covered with the paraffin they may develop under it. However, the paper wet with spirits could be put on first and the paraffin poured over it.

If paraffin is used, break it into pieces and put in a cup. Set the cup in a pan of warm water on the back of the stove. In a few moments it will be melted enough to cover the jelly. Have the coating about a fourth of an inch thick. In cooling the paraffin contracts, and if the layer is very thin it will crack and leave a portion of the jelly exposed.

Canned or Bottled Fruit Juices

Fruit juice is most desirable for drinking or for culinary purposes. Grape juice is particularly good as a drink. It may be canned with or without sugar, but, except where the grapes have a large percentage of sugar, as is the case in California, some sugar should be added to the juice in canning. Currant juice may be sterilized and canned without sugar. This juice may be made into jelly at any season of the year.

Fruit juices that are designed for use in frozen creams and water ices should be canned with a generous amount of sugar.

For grape juice good bottles are to be preferred to fruit cans. If you can get the self-sealing bottles, such as pop or beer comes in, the work of putting up grape juice will be light. If bottles are employed, be very careful to sterilize both bottles and corks.

Grape Juice

Wash the grapes and pick from the stems. Put the fruit in the preserving kettle and crush slightly. Heat slowly and boil gently for half an hour. Crush the fruit with a wooden spoon.

Put a sieve or colander over a large bowl and spread a square of cheesecloth over the sieve. Turn the fruit and juice into the cheesecloth; drain well, then draw the edges of the cheesecloth together and twist hard to press out all the juice possible.

Put the strained juice in a clean preserving kettle and on the fire. When it boils up, draw back and skim. Let it boil up again and skim; then add the sugar and stir until dissolved. Boil five minutes, skimming carefully. Fill hot sterilized jars or bottles. Put the jars or bottles in a moderate oven for ten minutes, in pans of boiling water. Have some boiling juice and pour a little of it into the jars as they are taken from the oven; then seal. Place on boards and set aside out of a cold draft. A good proportion of sugar and juice is 1 gill of sugar to a quart of juice.

Raspberry, Blackberry, Strawberry and Currant Juices

With all these fruits except currants, proceed the same as for grape juice, but adding half a pint of sugar to each quart of juice. Currants will require 1 pint of sugar to a quart of juice.

Cherry, Plum and Peach Juices

To preserve the juice of cherries, plums, peaches, and similar fruits, proceed as for jelly, but adding to each quart of juice half a pint of sugar instead of a quart as for jelly. If it is not desired to have the fruit juice transparent, the pulp of the fruit may be pressed to extract all the liquid.

Fruit Syrups

The only difference between syrups and juice is that in the syrup there must be at least half as much sugar as fruit juice.

These syrups are used for flavoring ice creams and water ices. They also make a delicious drink, when two or three spoonfuls are added to a glass of ice water.

Raspberry Vinegar

Put 4 quarts of raspberries in a bowl and pour over them 2 quarts of vinegar. Cover and set in a cool place for two days. On the second day strain the vinegar through cheesecloth. Put 4 quarts of fresh raspberries in the bowl and pour over them the vinegar strained from the first raspberries. Put in a cool place for two days, then strain. Put the strained juice in a preserving kettle with 3 quarts of sugar. Heat slowly, and when the vinegar boils skim carefully. Boil twenty minutes, then put in sterilized bottles.

About 2 tablespoonfuls of vinegar to a glass of water makes a refreshing drink.

Similar vinegars may be made from blackberries and strawberries.

MARIA PARLOA,

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Canning Vegetables in the Home

One of the many problems that confront the American housewife is the supply of vegetables for her table during the winter months. "What can I have for dinner today?" is a question often heard. Since the advent of the modern greenhouse and the forcing of vegetables under glass, fresh vegetables can usually be found at any time in the markets of the large cities. But the cost of forcing vegetables or growing them out of season is and will continue to be very great. This makes the price so high as almost to prohibit their use by people of moderate means, except as a luxury. A healthful diet, however, must include vegetables, and therefore the housewife turns to canned goods as the only alternative. These are sometimes poor substitutes for the fresh article, especially the cheaper commercial grades, which necessarily lack the delicate flavor of the fresh vegetable. There is practically no danger, however, from contamination with tin or other metals providing the containers are made of proper materials and handled carefully. In some cases the proper care is not taken in packing vegetables for market. The decayed and refuse portions are not so carefully removed as they should be and the requisite degree of cleanliness is not observed in their packing. Happily, however, such carelessness is not general.

Every housewife may run a miniature canning factory in her own kitchen, and on the farm this is especially economical and desirable, the economy being less pronounced in the case of city dwellers, who must buy their fruits and vegetables. Enough vegetables annually go to waste from the average farm garden to supply the table during the entire winter. But usually the farmer's wife cans her tomatoes, preserves her fruits, and leaves her most wholesome and nutritious vegetables to decay in the field, under the impression that it is impossible to keep them. This is a great mistake. It is just as easy to keep corn or string beans as it is to keep tomatoes, if you know how.

The same general methods for sterilization and canning operations should be followed in the canning of vegetables as in the canning of fruits.

So-Called "Preserving Powders"

There are a great many brands of so-called "preserving powders" on the market. These are sold not only under advertised trade names, but by druggists and peddlers everywhere. In the directions for use the housewife is told to fill the jar with the fruit or vegetable to be canned, to cover with water, and to add a teaspoonful of the powder. It is true that these powders may prevent the decay of the fruit or vegetable, but they also encourage uncleanly, careless work, and in the hands of inexperienced persons may be dangerous. While with small doses the influence may not be apparent in an adult in normal health, with a child or an invalid the effect may be of a serious nature. The proper way to sterilize is by means of heat, and as this can be done very easily and cheaply the use of chemical preservatives in canning is not to be recommended.

Kinds of Jars

The first requisite for successful canning is a good jar. Glass is the most satisfactory. Tin is more or less soluble in the juices of fruits and vegetables. Even the most improved styles of tin cans which are lacquered on the inside to prevent the juice from coming in contact with the tin are open to this objection. While the small amount of tin may not be injurious, it gives an undesirable color to many canned articles. Tin cans can not readily be used a second time, while glass with proper care will last indefinitely.

There are a great many kinds of glass jars on the market, many of them possessing certain distinct points of advantage. The ordinary screw-top jar is the one in most common use. Although cheap in price, these jars are the most expensive in the long run. The tops last only a few years and, being cheaply made, the breakage is usually greater than that of a better grade of jar. The tops also furnish an excellent hiding place for germs, which makes sterilization very difficult. An improved type of screw-top jar is now in use. These are fitted with a glass top held in place by a metal cover which screws down over the neck of the jar. If the canning or sterilization is conducted properly, practically all of the air will be driven out of the jar by the steam. Upon cooling, this is condensed, a vacuum is formed on the inside which clamps down the glass top against the rubber ring and seals the jar automatically. The metal cover can then be removed, as the pressure of the outside air will hold the glass top securely in place.

Another type of jar in common use requires no rubber rings, but is fitted with a metal top, lacquered on both sides and having a groove around the lower edge. This groove contains a composition of the consistency of rubber which is melted during canning by the heat of the jar and forms a seal that takes the place of the rubber ring. These metal tops must be renewed each year, as it is necessary to puncture them in order to open the jar.

The most satisfactory jar that the writer has had any experience with has a rubber ring and glass top which is held in place by a simple wire spring. There are several brands of these jars on the market, so no difficulty should be experienced in obtaining them. Vegetables often spoil after being sterilized because of defective rubbers. It is poor economy to buy cheap rubbers or to use them a second time. As a general rule black rubbers are more durable than white ones.

Buy a good grade of jar. The best quality usually retails at from a $1 to a $1.25 a dozen. The initial expense may be, therefore, somewhat high, but with proper care they should last many years. The annual breakage should be less than 3 per cent on the average. In selecting a jar always give preference to those having wide mouths. In canning whole fruit or vegetables and in cleaning the jars the wide mouth will be found to be decidedly preferable.

Containers for Sterilizing

The writer uses a tin clothes boiler with a false bottom made of wire netting cut to fit it. The netting is made of medium-sized galvanized wire (No. 16) with one-half inch mesh. A false bottom is absolutely necessary, as the jars will break if set flat upon the bottom of the boiler. Narrow strips of wood, straw, or almost anything of this nature may be used for the purpose, but the wire gauze is clean and convenient.

There are several varieties of patent steamers or steam cookers in common use. These have either one or two doors and hold a dozen or more quart jars. They are ideal for canning, but they are somewhat expensive and can be easily dispensed with. A common ham boiler or clothes boiler with a tight-fitting cover will answer every purpose.

Selection and Preparation of Vegetables

The first step in successful canning is the selection and preparation of the vegetables. Never attempt to can any vegetable that has matured and commenced to harden or one that has begun to decay. As a general rule, young vegetables are superior in flavor and texture to the more mature ones. This is especially true of string beans, okra, and asparagus. Vegetables are better if gathered in the early morning while the dew is still on them. If it is impossible to can them immediately, do not allow them to wither, but put them in cold water or in a cold, damp place and keep them crisp until you are ready for them. Do your canning in a well-swept and well-dusted room. This will tend to reduce the number of spores floating about and lessen the chances of inoculation.

In the following pages are given instructions for canning some of the more common vegetables, but the housewife can add to these at will. The principle of sterilization is the same for all meats, fruits, vegetables.

Corn

Contrary to the general opinion, corn is one of the easiest vegetables to can. The United States Department of Agriculture has shown that the amount of sugar in the sweet varieties diminishes very rapidly after the ear is pulled from the stalk; therefore in order to retain the original sweetness and flavor it is necessary to can corn very soon after it is pulled—within an hour if possible. Select the ears with full grains before they have begun to harden, as this is the period of greatest sugar content. Husk them and brush the silks off with a stiff brush. Shear off the grains with a sharp knife and pack the jar full. Add salt to taste, usually about a teaspoonful to the quart is sufficient, and fill up the jar to the top with cold water. Put the rubber ring around the neck of the jar and place the top on loosely. Be careful not to press down the spring at the side of the jar.

Place the false bottom in the boiler and put in as many jars as the boiler will conveniently hold. Don't try to crowd them in. Leave space between them. Pour in about 3 inches of cold water, or just enough to form steam and to prevent the boiler from going dry during the boiling. It is not necessary to have the water up to the neck of the jars, as the steam will do the cooking. Put the cover on the boiler and set it on the stove. Bring the water to a boil and keep it boiling for one hour. At the end of that time remove the cover of the boiler and allow the steam to escape. Press down the spring at the side of the jar. This clamps on the top and will prevent any outside air from entering. The jars can now be removed and cooled or allowed to stand in the boiler until the next day.

On the second day raise the spring at the side of the jar. This will relieve any pressure from steam that might accumulate inside the jar during the second cooking. Place the jars again in the boiler and boil for one hour. Clamp on the top as on the preceding day and allow them to cool. Repeat this operation on the third day. In removing the jars from the boiler be careful not to expose them to a draft of cold air while they are hot, as a sudden change in temperature is likely to crack them.

After the sterilization is complete the jars may be set aside for a day or two and then tested. This is done by releasing the spring at the side and picking up the jar by the top. If there has been the least bit of decomposition, or if sterilization has not been complete, the top will come off. This is because the pressure on the top has been relieved by the gas formed by the bacteria. In this case it is always best to empty out the corn and fill up the jar with a fresh supply. If canning fruits or some expensive vegetable, however, examine the contents of the jar and, if the decomposition has not gone far enough to injure the flavor, place it once more in the boiler and sterilize over again. If the top does not come off, you may feel sure that the vegetable is keeping.

String Beans

Select young and tender beans, string them, and break them into short lengths. Pack firmly in the jar, cover with cold water, and add a teaspoon of salt to each quart. Put on the rubber and top and boil for one hour on each of three successive days, as directed under "Corn." A small pod of red pepper placed in the bottom of the jar will give a delightful flavor to this vegetable.

Egg Plant

Pare the egg plant, cut in thin slices, and drop in boiling water for fifteen or twenty minutes. Drain off the water and pack the slices in the jar. Cover with water and sterilize as directed under "Corn." The slices of egg plant are pliable and may be taken from the jar without being broken and either fried in bread crumbs or made into pudding and baked.

Beets

Although beets will keep in the cellar over winter, it is very desirable to can them while they are young and tender, as the mature beet is apt to be stringy and lacking in flavor. Wash the young beets, cut off the tops, and put them in boiling water for about an hour and a half, or until they are thoroughly cooked. Take off the skins, cut in thin slices, and pack into the jars. Cover with water and sterilize in the manner previously described. If a mild pickle is desired, make a mixture of equal parts of water and good vinegar, sweeten to taste, and cover the beets with this mixture instead of water.

Okra or Gumbo

This is a vegetable worthy of more extended culture. Although extensively grown in the South, it is comparatively unknown in the North. It is easily kept and makes a delicious vegetable for the winter. Wash the young and tender pods, cut them in short lengths, pack in the jars, cover with water and sterilize. Okra is used for soups or stews.

Summer Squash

Cut the vegetables into small blocks, pack in the jars, and cover with water. Add a teaspoon of salt to each quart and sterilize. It is sometimes preferable with this vegetable, however, to pare off the skin, boil or steam until thoroughly done, mash them, and then pack in the jars and sterilize. If canned in the latter way, it is advisable to steam them for an hour and a half, instead of for an hour, on each of three days, as the heat penetrates the jar very slowly. It is absolutely necessary that the interior of the jar should reach the temperature of boiling water. A jar will usually hold about twice as much of the cooked vegetable as it will of the uncooked.

English Peas

When prepared and canned in the proper way, peas are easily kept and never lose the delicate flavor that they possess when fresh. Shell the young peas, pack in jars, and sterilize as directed under "Corn."

Asparagus

Can the young tips only, in the same way as you would corn.

Cauliflower

This vegetable usually keeps very well, but if the supply for the winter should begin to spoil it may be necessary to can it during the summer. Prepare it as you would for the table, pack it into jars, and sterilize.

Carrots and Parsnips

These, if gathered during the early summer and canned, make most excellent vegetables for the winter. The young plants at that season are not stringy and have not yet developed the strong taste that is so objectionable to some people. Prepare as you would for the table, and sterilize.

Tomatoes

Every housewife knows how to can tomatoes. They are very easily kept, even in the common screw-top jar. If one already has on hand a number of jars of this pattern, it is best to use them for preserves or for canning tomatoes and to purchase the more modern styles for canning other vegetables. In using the screw-top jars be careful to sterilize them first by placing in cold water, bringing to a boil, and boiling for about ten minutes. The rubber and top should also be immersed in boiling water for the same length of time. Remove them from the boiling water when needed, handling as little as possible. Be careful not to put the fingers on the inside of the top or the inner edge of the rubber. Fill the jar with the cooked tomatoes while steaming hot, put on the rubber, screw on the top firmly, invert it, and let it stand in that position until cool.

Kohl-Rabi

This vegetable resembles the turnip in its habits of growth, although in flavor it more nearly approaches the cauliflower. It is grown in many sections of the North, but in the South it is almost unknown. Prepare it as you would turnips, pack in the jar, and sterilize.

Lima Beans

Lima beans lose their flavor very quickly after being shelled; therefore it is necessary to can them as soon as possible after gathering. Discard all pods that have begun to harden, and proceed as you would with corn.

Pumpkin or Winter Squash

If provided with a warm, dry cellar, one may keep certain varieties of these vegetables all winter. Some of the best varieties, however, do not keep well, and even the best keepers when not properly housed begin to decay in December or January. It is then necessary to can them in order to save them. If one has a limited number of jars, it is a good plan to fill them all with other vegetables during the summer and upon the approach of frost to gather the pumpkins and bring them indoors. By the time the pumpkins begin to spoil, enough jars will be emptied to hold them. They can now be steamed and canned in the same way as summer squash. In this way a supply of jars may be made to do double service.

Succotash

The writer has found that a mixture of corn and lima beans, or succotash, is one of the most difficult things to keep. This furnishes one of the very best mediums for bacterial growth; so extreme care must be taken in the process of canning. It is advisable to gather the corn and beans early in the morning and prepare and sterilize them in the manner already described. As with summer squash, it is best to boil for an hour and a half, instead of for an hour.

Vegetable Roast

A rather unusual dish for the winter may be made by canning a mixture of vegetables. Prepare corn, lima beans, tomatoes, string beans, okra, squash, and egg plant as you would for canning separately. Mix these in varying proportions, letting the corn and lima beans predominate. Add two or three midium-sized onions to each quart of this mixture and run all through a food chopper in order to mix it thoroughly. Pack into jars and sterilize. In preparing for the table mix with an equal volume of bread crumbs, a piece of butter the size of a walnut, and one egg; season to taste with pepper and salt, and bake in a round baking dish until brown. Cut into slices as you would a cake and serve hot with a drawn butter sauce.

Corn, okra, and tomatoes, mixed in equal proportions, may be canned in this way as a soup stock.

Freshness of Flavor and Color

Vegetables when canned properly should retain their attractive color and lose very little of their flavor. It will be found almost impossible to detect any difference either in taste or in appearance between the canned and the fresh article if these directions are carefully followed. The volatile oils which give flavor to most vegetables are not lost during this process of sterilization. Cooking for *three short periods* in a *closed* container at a comparatively low temperature instead of cooking for one short period at a high temperature or for *one long period* in an *open* vessel makes the vital difference and insures freshness of flavor and color. After the jars have been sterilized and tested, they should be kept in the dark, as the sunlight will soon destroy the color of the vegetable.

How to Open a Jar

Jars of vegetables are sometimes hard to open, unless it is done in just the right way. Run a thin knife blade under the rubber, next to the jar, and press against it firmly. This will usually let in enough air to release the pressure on the top. In case it does not, place the jar in a deep saucepan of cold water, bring to a boil, and keep it boiling for a few minutes. The jar will then open easily.

Cautions

These directions for canning apply only to pint and quart jars. If half-gallon jars are used, always increase the time of boiling, making it an hour and a half instead of one hour.

Do not go into canning too deeply at first. Experiment with a few jars in the early part of the season and see if they keep well. It is not a difficult matter to can vegetables properly. The writer has never lost a can of string beans, okra, egg plant, carrots, parsnips, lima beans, beets, asparagus, or pumpkin in several years' experience and, has had only one can of peas spoil, a few cans of corn during the earlier trials, and a few cans of succotash. Any housewife can do equally well. If you follow the directions here given carefully, you will have no difficulty whatever. If you should happen to fail in the first trial, rest assured that you have done something wrong or left something undone. No housewife who has on hand during the winter a supply of home-canned vegetables ready to serve on ten minutes' notice will ever regret the trouble or difficulties experienced in learning.

J. F. Beazeale,
Bureau of Chemistry, U. S. Department of Agriculture.

Amount and Value of Canned and Dried Fruit in the United States

[*] PRODUCT	1909	1904	1899
Total value	$157,101,201	$130,465,976	$99,335,464
Fruits and Vegetables.			
Value	$86,422,383	$72,998,756	$44,802,665
Canned Vegetables:			
Cases	32,834,820	29,579,616	19,323,730
Value	$51,568,914	$45,610,993	$28,734,598
Tomatoes—			
Cases	12,980,818	9,411,084	8,700,538
Value	$18,747,941	$14,020,846	$13,666,560
Corn—			
Cases	7,451,265	11,209,597	6,336,984
Value	$10,332,136	$15,952,386	$8,191,383
Peas—			
Cases	5,901,703	4,694,492	2,543,722
Value	$10,247,368	$7,928,791	$4,465,673
Beans—			
Cases	3,393,200	2,588,015	1,493,517
Value	$6,013,098	$4,133,810	$2,025,123
Asparagus—			
Cases	229,742	....	....
Value	$1,975,775	....	....
Pumpkins—			
Cases	438,426	246,557	138,078
Value	$576,048	$346,497	$202,404
Sweet Potatoes—			
Cases	347,186	192,997	88,526
Value	$531,651	$284,385	$124,245
All Other—			
Cases	2,092,470	1,236,874	27,365
Value	$3,144,907	$2,944,278	$59,210
Canned Fruits:			
Cases	5,461,233	4,628,241	4,467,817
Value	$12,938,474	$11,722,979	$11,311,062
Peaches—			
Cases	1,484,808	1,304,867	1,449,356
Value	$3,753,698	$3,902,441	$4,283,165
Apples—			
Cases	1,205,774	490,341	645,762
Value	$1,898,720	$738,013	$1,125,119
Apricots—			
Cases	562,811	539,815	531,648
Value	$1,825,311	$1,641,919	$1,583,252
Peas—			
Cases	641,291	789,120	672,485
Value	$1,838,214	$2,192,910	$2,188,201
Berries—			
Cases	830,324	489,637	600,419
Value	$1,783,026	$1,058,659	$1,092,975
Cherries—			
Cases	382,116	319,350	114,367
Value	$990,914	$825,522	$307,788
All Other—			
Cases	354,109	695,111	453,780
Value	$853,591	$1,363,515	$730,562
Dried Fruits—			
Pounds	484,328,767	343,579,623	85,439,406
Value	$21,914,995	$15,664,784	$4,757,005
Raisins—			
Pounds	195,774,767	121,409,881	14,984,221
Value	$6,912,533	$6,349,381	$1,062,268
Prunes—			
Pounds	138,498,490	117,808,181	25,413,763
Value	$5,130,412	$3,299,628	$970,927
Apples—			
Pounds	44,568,244	40,737,089	33,212,309
Value	$3,098,095	$1,758,610	$1,906,642
Peaches—			
Pounds	46,843,391	25,861,074	5,662,390
Value	$2,423,083	$1,702,205	$312,495
Apricots—			
Pounds	29,205,569	19,559,573	5,465,217
Value	$2,277,177	$1,410,838	$455,394
All Other—			
Pounds	29,438,306	18,203,825	701,509
Value	$2,073,695	$1,144,122	$49,276

Of factory dried fruit California produced $18.212,316, or 83.1 per cent of the total value of this class of products.

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[*] Census Bulletin of Manufactures, 1913.

Cantaloup Culture

Introduction

The cantaloup in its season is probably the most popular fruit on the American table, appearing prominently on every first-class menu.

The total consumption in the United States, amounting to ten thousands of carloads, besides the local home-grown product which can hardly be estimated, indicates an industry of great importance.

From the growers' standpoint, however, the story of the melon industry is filled with disappointment and failures, difficulties and disheartening returns, which are all but discouraging at times, yet each season some growers are making a decided success of the crop, either through a better experience, more favorable conditions, or exceptional opportunities. Although the grower himself may not always realize the determining elements of his success yet to a careful observer it is evident that many of the factors that cause failures in cantaloupes could be overcome by a better grasp of essential points; for instance, a better knowledge of the experience of other growers, a fuller understanding of the needs of the markets, the best methods of harvesting and handling the crop, and the most favorable system of marketing for the highest returns.

The various cantaloup districts of the United States have been canvassed for any new information on cantaloupes, and this information has been embodied in this article covering the most essential points in regard to good seed, cultural care, harvesting and marketing, also experience and suggestions on insects and plant diseases.

Points for Commercial Growers to Consider

In order that preparation may be made for a better appreciation and understanding of some of the determining factors that may result in success or failure in cantaloup growing consideration is asked of the following questions:

First, Are your seasons long enough, and the climatic conditions favorable for cantaloup growing?

Second, Are you accessible to markets, or good railroad facilities?

Third, Will your cantaloupes come in competition with those from other districts and cause a glutted market?

Fourth, Have you some peculiar advantages which will enable you to meet competition?

Fifth, Have you had experience in handling cantaloupes, and do you realize that it requires under favorable conditions 100 to 150 acres to profitably ship in carload lots?

Sixth, Have you any marketing agencies to assist in disposing of your crop, or will you depend upon open consignments?

Seventh, Have you considered your market demands as to varieties, and do you know what strains of seed would be best adapted to your conditions?

Eighth, What importance do you place on good seed breeding? Do you know that common, ordinary seed may produce as fine specimens as the best seed, but that the well bred seed *will* produce a greater per cent of uniform, marketable cantaloupes?

Ninth, Are you aware that the highest grade of seed can not insure you a crop under adverse conditions, of weather, poor soil or careless management?

Tenth, Do you realize that one failure, or even several, does not prove that success is not possible?

It is not our purpose to call attention to all the possibilities of failures nor suggest all the points of encouragement, but if a grower can realize the essential points, we feel that the cantaloup industry will be on a more stable footing.

In the first place the large acreage for an individual grower should be discouraged, except in the special cantaloupe growing districts where growers have had experience in handling large acreages. If a large acreage is required to make carload shipments, it would be best to have an aggregation of a large number of small acreages handled by individuals working in co-operation.

Specialized cantaloup growing has been made a success in a few localities by a large number of growers, but has been attended with ups and downs, of over-production and glutted markets. But there is a great opportunity for a few growers in a great many localities to specialize in cantaloupes, to work up a fancy trade, and to study to cater to that trade and supply them with only the best, that will result in success where now only indifferent results are secured. The grower who considers only the producing side of the industry has not measured one-half of the question, for marketing to a profit is the biggest side.

The Importance of Good Seed

It is often argued that seed saved from over-ripe cantaloupes are just as good for seed, which on first thought might seem true, but why is a cantaloup over-ripe, when the fields have been picked over twice each day as they should be? It is true it may have been overlooked, but more probably the majority of "over-ripes" are so because there is an inherent weakness toward rapid ripening, in reality a poor keeping quality; hence if we plant seed saved from over-ripe cantaloupes that are culled from where the bulk of the cantaloupes are marketed, we are propagating just the traits that we do not want in our cantaloupes for market.

Seed breeding means more than the selection of seed from an average crop; *that would tend only to produce average results.*

The same laws that govern the breeding of animals also control the improvement of plants. Any fair-minded man will acknowledge that thoroughbred animals are more profitable than scrubs, or even average stock, and the same is true of plants. But we must get the true conception of seed selection—not the idea of the uninformed farmer who, with his wife spent their evenings for many days selecting seed corn from a lot of shelled corn that he had purchased for feed. The man who selects his cantaloupe seed at the packing shed is almost as far wrong, for the *plant* that produced the seed has not been considered.

Nature makes selections that the grower may often overlook; for instance, cool nights and a short season will act as a natural selection to develop the early maturing types, hence the seed from the arid region in high altitudes has proven to be superior to seed growing in the humid sections, both for vigor and early maturity. The big cantaloup growers from California and the Southern states realize this, for they look to Rocky Ford each year for their cantaloup seed, and all testify that they get earlier and more uniform cantaloupes from the Rocky Ford grown seed.

Yet because cantaloupes from Colorado are the last to appear on the markets, some might suppose that the seed from there would be late in maturing, when in fact the very opposite is true.

Some Points That Seeds Will Not Overcome

Poor results are often attributed to poor seed, which is doubtless often the case, but there is evidence to show that complaints about seed may sometimes be made when the trouble is due to other causes; for instance, two fields may be planted with the same stock of seed, but having different soil fertility, or cultural care, may show widely different results in yield, size and uniformity of the crop.

As for example, a grower in Texas who complained that certain seed produced too many "jumbo" sizes, while from Southwest Arkansas another complaint from the same strain of seed was to the effect that the cantaloupes were running too small, yet this grower admitted that dry weather checked his vines somewhat.

Some people seem to think that the crop should show absolute uniformity; this is next to impossible, although a study of the ideal representations and the elaborate descriptions in some of the seed catalogues might convey this impression. *The fact is, cantaloupes do vary even in the best strains of seed;* one can frequently find on one vine, one cantaloup that is very long, while another may be short and round; this is especially true if the vine has made an unusual growth on account of rich soil or other favorable conditions.

The size of the cavity, the development of the netting, and the appearance of the cantaloupes will vary on different types of soil to some extent, and different seasons will lead the grower to think that the seed was not up to standard of the year before when the seed was equally good, but the season was not as favorable in some respects that this grower overlooks. The same seed out of the same sack has been planted on different days, one just before a rain that was cold and the other after it had warmed up; one came up slowly, small and puny, while the other made a fine growth.

Any influence that tends to retard or stimulate the growth of the vines will also, in some way or another, affect the results of the crop; such influence may not be serious, possibly only a few oversized melons, making packing a little more difficult, but *one must expect some variations due to environment. These may be favorable or unfavorable, and they may or may not be under the control of the grower.* There is a long list of these factors—character of the soil, fertility, moisture supply, climate, insect pests, plant diseases, and cultural care; all of these must be considered and controlled, if possible, if we would secure the greatest uniformity in results.

Heredity of the seed is another great factor influencing results and one that is often difficult to determine since there are always the two forces, *environment* and *heredity*, at work, and *which of these causes has produced a given effect will often be the question.*

The only fair way to pass judgment upon the merits of a certain stock of seed is to compare its results with those of other seed under exactly the same conditions. It is the only means of reading heredity in any system of plant breeding. The methods of plant breeding for the different crops are essentially the same, namely, a nursery test of the seed from individual plants, selected for given traits, and which are then grown under uniform conditions to determine their relative merit.

Method of Developing High Grade Seeds

The method is to select a large number of individuals, save the seed separately and plant in adjacent plats at the same time, under as uniform conditions as possible, to test out their breeding tendencies—this is called a nursery test.

The individual plant is the unit of variation, and hence should always be made the unit of selection. The results of systematic seed selection have clearly shown that there is a wide variation in different plants from even fairly pure seed, and that the more nearly a strain of seed can be the progeny from a single plant, the more uniform and strong its hereditary tendencies will be, provided that the individual plant is not a hybrid, in which case it may break up into a variety of types; but even in long established strains of pure bred seed there is still the continual "reverting" or "breeding back," so that it is not uncommon to find a cantaloup that is a little "off," so if the general average of the crop is pretty uniformly true, one need not suspect a mixture by the appearance of a little variation.

Sometimes a variation is along very desirable lines, for there are numerous instances where the selection of the seed from a single plant that seemed different, has been the beginning of a new strain much superior to the original; such was the history of the disease-resistant Pollock cantaloup, while the

Ryan's Early Watters was started from a single early maturing plant.

There is plenty of seed saving, but comparatively little seed selection along systematic lines, and there is still less seed breeding for improved hereditary traits. Usually twenty-five hills are planted in each plat, and all are given uniform conditions that the differences that may develop may reasonably be ascribed to heredity, and the new selections made accordingly.

A number of the choicest individual fruits from the most desirable plats are again saved for the next year's nursery test, and the plats that run most uniformly alike along desirable lines, are then cut for stock seed. In this way the weak traits and undesirable tendencies of any individual plant may be eliminated more and more each year, while the strong desirable traits are retained and thus the average uniformity gradually increased as far as possible.

It will readily be seen that it requires the same care to maintain a grade of quality that it did to build it up in the first place, *the tendency to deteriorate being always present.*

The first nursery grown, before the seed had been bred up much, would have the appearance of a large checker board, because of the many variations. Some would be disease-resistant and some not; some would be early and some late; some prolific and others not, while in netting, color of the flesh, and the size and form of the fruit, the contrasts would be also very marked.

Aside from improving and combining desirable traits, *the nursery test* for cantaloupes has another strong point of merit, namely, *keeping the stock seed pure.* It is evident that if seed from individual cantaloupes are planted separately in different plats, it would be easy for a keen observer to detect the presence of a hybrid and thus eliminate that plant from being saved for stock seed.

So marked have been the results and advantages of the breeding from individual plants to secure uniformity and desirable traits, that no one who has followed it up intelligently can doubt the efficiency of the method; but at the same time it is very evident that it takes care and a good deal of time to accomplish results which at first may seem easy.

Seed breeding is practical; it is not a theory or a fancy, but a reasonable, result-producing process. The most successful farmers are giving it careful consideration, nor does the improvement of seed add a burden of labor and expense, but comes as an added asset to the grower's wealth, and increases his pride in his crop.

Comparatively few men are capable of producing their seed for if they are growing cantaloupes for market, their time and attention must be occupied with the crop, and to select, cut and cure high-grade cantaloup seed requires no little *training and experience*, and some little equipment.

The grower who buys his seed should deal directly with a reliable breeder who is qualified, and is making a specialty of growing the crop for seed; a grower should not submit his seed order for "*lowest bid*" if he expects to get the best seed.

Conditions and Cultural Care

Climate

The cantaloup seems to thrive in rather a wide range of soil and climatic conditions, being grown to some extent in almost all of the states, although from the standpoint of money returns, the area of very successful cantaloup culture is somewhat limited; yet it appears that it is more the question of cultural care, disease and insect pests, or favorable marketing facilities, which determine the success of the industry in a given locality, rather than the specific soil or climatic conditions.

Climatic conditions within certain limits are essential to successful cantaloup culture, and the consideration of this topic may answer many questions as to the adaptability of some sections for melon growing. First, there should be a *long, hot summer*, with about five months free from killing frosts, with a daily maximum temperature between 80 and 95 degrees during June, July and August, with a night temperature seldom falling below 60 degrees; four months may mature good cantaloupes, but with so short a season frost would probably cut short the profits of the crop, unless, as is done in some of the Northern states having too short season, the plants are started under frames in sods or paper bands; second, there should be plenty of bright sunshine, without excessive rainfalls; this will secure good quality and lessen liability to attacks of fungus troubles that are so often fatal to the melon crop in rainy sections or regions of heavy dews; without doubt the clear bright sunshine and the arid conditions of Southeastern Colorado account for the high flavor and the fine qualities found in the Rocky Ford cantaloupes as compared with the poor quality in the cantaloupes with an abnormal rain fall, which sometimes occurs.

Sunlight is very essential to the full development of cantaloupes, for the quality is perceptibly inferior in shaded spots; the dry atmospheric conditions cause rapid transpiration of the moisture from the leaves, thus inducing a quick movement of sap or plant juices which increases the power to carry and deposit plant foods, thus developing and concentrating the spice of flavor and producing the very highest qualities.

We do not recommend cantaloupes to be planted in an orchard where there is any shade to speak of, as they will not do well.

Plate No. 2. Contrast in Growth of Vines: on the Left Alfalfa Sod; on the Right Old Land.

Soil and Fertility

It is conceded by all experienced cantaloup growers that the cantaloup thrives best in a warm, sandy loam; clay loam and other types of soil may produce a good crop if the tilth and fertility are good, but heavy soils are apt to be cold and backward, causing lateness in maturing, and it is also generally believed that the nature of some types of soils seriously influences the form, size and other qualities of the cantaloup. It is true, however, that the average size will vary in different seasons; in seasons of very favorable growth the cantaloupes will run to a large proportion of "jumbo melons" (larger than standard); in seasons less favorable there will be more small or pony sizes. An actual test of a crop on a piece of land is the *best* proof of the fitness of the soil for that crop, for while a chemical analysis may theoretically seem favorable, in practice it may prove otherwise.

There are many factors that may influence the results, but in general the land that will grow other vine crops, such as cucumbers, pumpkins and squash, will probably grow good cantaloupes.

Soil for cantaloupes should have good drainage, both surface and subsoil, and in irrigated regions the land must have a uniform slope or grade so that the water will run even, without soaking or flooding the hills; if there is one point above another in cantaloup culture that needs special emphasis, it is the caution against *oversoaking* or *flooding* of the surface of the field; this will be further discussed under the topic "Irrigation," but the point must be held in mind in many of the operations, and in selecting the field, to have it well drained on the surface as well as the subsoil.

If no detrimental soil conditions like seepage, or alkali, exist, the question of fertility is usually the most important one in relation to the soil; barnyard manure is an old standby, and cantaloupes, of all crops, will respond as well to well-rotted compost as to any form of commercial fertilizer, but experience of the most convincing sort has

Plate No. 3. The Contrast Between an Imperfect and a Perfect Cantaloup.

shown that soil cannot be made to produce good cantaloupes indefinitely, year after year, by applying manure and artificial fertilizers.

Aside from fertility there are also the questions of plant diseases, soil bacteria, and unbalanced food supply. *Crop-rotation* has proven to be the most practical and adequate means of preserving not only the proper fertility, but the nearest approach to securing uninfested soil conditions, hence crop rotation becomes an important phase of cantaloup culture

Alfalfa to the western ranches occupies the same place that clover does to the eastern farmer, or the cow pea to the southern planter; these crops for their respective sections provide ideal soil fertility and tilth for the cantaloup. In Colorado alfalfa sod is the ideal soil preparation for cantaloupes, and a comparison of the results on alfalfa sod with even well manured old land will convince the most skeptical. (Plate No. 2.) Experience has demonstrated that early matured cantaloupes can hardly be expected on soil following a heavy fertility consuming crop, like sugar beets or corn, a good *late crop* being the usual result. Nearly all the fine records of early yields and high prices have been made on soil that was in a perfect state of tilth and fertility.

Soil *can* be made *too rich* in applying manures, and the principal point in the application of fertilizers is to have a reasonable amount, and well incorporated in the soil, and in the case of barnyard manure to have it well rotted. In Colorado manuring in the hill has been found to have no advantage over the broadcast method, owing probably to the wide spreading root system of the plant; *commercial fertilizers have not been profitably used in Colorado.*

Preparing Land for Cantaloupes

The secret of getting soil in that ashy, mellow condition so desirable for cantaloupes, is one largely of experience, for handling soil in the same manner on different farms will seldom get the same results; one may be a clay, the other a sandy loam. The texture and the previous cropping has much to do with the way the soil can be handled. In general there must be moisture in the soil during the winter to secure the mellowing effect of the frost, and the soil *must not* be handled too wet. If clay or adobe "packs" it will dry hard and lumpy; real sandy soil can be handled wet with less risks than other soils. The soil should be friable so that the harrow will pulverize it without clogging as it does in mud, and yet not so dry as to leave the field full of clods.

Before plowing the soil should be well disked for two reasons. First, to thoroughly mix the soil with any fertilizer previously applied, and, second, to pulverize the soil on the surface, so that after the work of preparation is complete, the bottom of the furrow will be as finely prepared as the top. Plowing for cantaloupes is usually made to the depth of five to six inches; in the arid region the plowed land must be closely harrowed behind the plow, to prevent too rapid drying of the surface, and should be closed up by fining the soil on top; this is usually accomplished with the steel harrow with the teeth turned nearly flat, or with a float or land-leveler. A fine dust mulch will check evaporation, and

Plate No. 4. Leveling Land, and Fining the Soil.

thus conserve the soil moisture, to enable a more thorough harrowing to complete the preparation. Preparing the land some time before planting is advisable, as the soil becomes settled and the seed will germinate more readily and a more uniform stand will be secured. The soil should also be harrowed after *cold spring rains* to check evaporation, which will tend to aid in warming up the soil. Before laying out the rows to plant, while the surface of the soil is dry, the field should be carefully leveled with a land leveler (see Plate No. 4), removing all the high points and filling the hollows and dead furrows so that in irrigating the water will run uniformly without flooding the rows, or oversoaking any of the hills.

About planting time the field is laid off with a marker in rows five to six feet apart, in the opposite direction to the rows to be planted, which are laid off with the irrigation furrows in the best direction for water to run. The irrigation rows are usually made about the same distance apart, usually six feet; these furrows can be made with a single shovel plow or a two-row marker or furrower. In the non-irrigated regions these furrows could serve for surface drainage after heavy rains.

Planting and Securing a Stand

The first requisite in planting cantaloupes is to have the weather *warm*, for warmth and moisture are the two essentials in seed germination. Many growers make the mistake of planting while the ground is yet cold with freezing temperature occurring every few nights. If perchance the days are warm enough to germinate the seed, the plants are stunted and make a slow, tantalizing growth, should they be so fortunate as to escape these late frosts of spring.

As a general rule, a few days before the latest freeze may be expected, is as early as is safe to plant. It is *common* for cantaloupes planted as early as the tenth of May to begin to ripen as soon as the earlier planted seed, so as a rule it is not to much advantage to plant very early; the *grower* must be the judge in regard to his soil and climate.

There are two systems of planting cantaloupes—the *drill-row* and in hills. In the hill system the field is check-rowed like corn, to permit cultivating in each direction, the rows usually being laid off five to six feet apart, and the hills about the same distance in the rows. By dropping eight to ten seed to the hill, it will require about a pound of seed to plant an acre. It is advisable to plant plenty of seed in order to secure a good stand allowing for the attacks of the cutworms and other destructive agencies.

There are two methods of planting cantaloupes in hills—with a hoe, and with a hand planter, commonly called a "snapper." The rotary type of this form of planter is usually the most satisfactory, but some modifications are usually necessary to fit it for dropping cantaloupe seed.

By filling the holes of one of the regular corn-dropping plates with lead, then by boring out with a three-eighths drill bit and by testing and enlarging the holes it can be regulated to drop quite well; the seed box will also need close fitting, to prevent the thin flat seed from leaking out. A block or stop should be attached to the blades at about the depth to plant, about one and a half inches; this will insure uniform depth, which is essential. Great care should be exercised to have the depression or hole formed in the soil by the thrust of the planter filled or leveled with the foot; otherwise the seed will dry out, field mice will more

Plate No. 5. Planting Cantaloupes with Garden Drill.

readily find the hills, and a hard dash of rain will form a hard chunk, or crust, right over the seed. The surface of the soil should be *dry* to insure good work with the planter. A man with some experience can plant from three to five acres per day with a planter, while one acre per day is about all that can be accomplished with a hoe.

The principal argument for the hill system of growing cantaloupes is the economy of labor, for more of the weeding and hoeing can be done with a horse.

In the drill system the rows are usually put about the same distance apart, but the seed are sown in drill rows, the seed being dropped every two or three inches; this method requires about two to three pounds of seed per acre. The seed is sown either with a hand drill, shown in Plate No. 5, the horse planter, or the sugar beet drill is used. The important point is to get the seed dropped uniformly, and the drill set to plant at a uniform depth — not over one and a half inches; as soon as the plants are nicely up they should be thinned to single plants, far enough apart to permit hoeing between. After the danger from insect injuries is over, and about the time the first blossoms appear, the plants should be thinned again to one plant every two feet, on the average; the tendency at this point is to leave the plants too thick, especially if the plants are extra fine. The most advanced plants are selected, which is the cause of the drilled fields usually maturing earlier than the hill planted, and the earlier development usually compensates for the extra cost of the increased amount of seed, and the added labor of thinning.

The essential points in planting are to get the seed planted at a uniform depth, and at a uniform distance from the irrigation furrow; to have the soil fine and firmed just right, to skillfully conserve and apply moisture, and to keep a crust from interfering with the young seedlings.

In the arid regions the seed is usually planted about one-half inch deeper than it is expected the plants will come through, in order to hold the moisture line to the seed. When the seed is well sprouted the hills are raked off with a garden rake, removing the crust and any clods that might interfere. Sometimes the field is harrowed across the rows with good results, especially where the rows are drilled in. This matter of "raking off" and keeping the surface fine over the hills is a *very important point* to be observed in securing a good stand.

Irrigation

The moisture problem in cantaloup growing is a very important one. Some times in the humid sections, there is too much water, and it becomes the question of how to save the crop; but little can be said here, except to select well drained fields for the cantaloupes and provide the field with furrows, like the irrigation furrow, to carry off the excess rain water, and to plant on somewhat raised hills or ridges.

In the arid sections the moisture for the crop as a rule depends on the irrigation furrow, and the skill of the grower to so manipulate the soil and water. Too many look upon irrigation as a simple process of running water through the rows, or over the ground, paying little or no attention to the *needs* or *demands* or the dangers of flooding or oversoaking the land. When soil is completely saturated with water the air is practically all driven out and the soil settles, which defeats the very object and purpose of plowing and the other work of soil preparation, which will dry hard and nothing but frost can ever mellow it as before.

The application of water to all such crops as cantaloupes should be by subirrigation, that is, the moisture should soak through the soil to the plant or seed, from the irrigation furrow, without the surface of the soil, except in the furrows coming in contact with the water; this is essential not only for the needs of the plant but also the same amount of water will serve a longer time the needs of the plants, the water rights in some ditches making it necessary to conserve the moisture as long as possible.

In order to supply the moisture uniformly to the seed along the row, the seed must have been planted at a uniform distance from the water line, about four to six inches; to insure uniformity in the soaking of the rows, the rows should be "logged" out, or smoothed out with a short piece of log about the size of the furrow; this will cause the water to run through quickly, and by regulating the amount in each row, the rows will become uniformly wet without flooding or soaking the ground. Plate No. 6 shows a field being properly irrigated, to germinate the seed. When the water can be gotten through the rows quickly and the amount regulated to supply the rows about as fast as it soaks in the soil, the upper and lower parts of the row will become wet at about the same time and amount, with practically little water wasted.

Plate No. 6. Irrigating for Germination of Seed.

The idea is to soak the rows until the water has fully reached the seed, while the surface over the hill remains nearly dry; this is *ideal condition* for *germination* and is sufficient for the needs of the plants in all the early irrigations. Later the rows can be soaked till moisture shows on the surface back to the plants.

Under arid conditions one irrigation after planting, and one again about the time the plants are coming up, is ordinarily all that is required until after the first cultivation; after that irrigation and cultivation alternate each other every week or ten days, the exact number of times depending on the weather and soil conditions.

The amount of irrigation necessary to secure the best results in cantaloup culture, is subject to so many varying factors, that it is impossible to lay down an exact rule. In the first place, the cantaloup does not thrive in a wet soil, as evidenced by the injury and poor quality of the crop in seasons of excessive rain. The needs of the crop in the first stages are very small, and as light watering as possible to secure the needed moisture is best; then as the plant develops the amount of irrigation should be increased; *light, frequent irrigations* rather than heavy soakings at long intervals has proven to be the best plan.

When the vines are nearly grown and set full of developing fruit a heavier irrigation is then needed by the plant, but as soon as the fruits have reached their growth, light waterings should again be the rule; to insure the best quality, little if any irrigation should be applied during the picking season, just enough to prevent severe wilting; it is at this time that the cantaloup "rust" fungus makes its appearance, and moisture and dews are favorable to its development.

The dryer the season, the better the quality in cantaloupes, is an axiom that should induce more careful irrigation among cantaloup growers in the irrigated sections.

The relation of irrigation to early setting of cantaloupes is a somewhat mooted question; there are growers who argue the use of frequent irrigations during the setting period in order to secure a good set, but others prefer to keep their vines dry, even allowing them to show the need of moisture before they will permit irrigation during this stage.

It is evident that the season and climatic conditions have more to do with the setting of fruit than the watering; there are experiences that might seem to support both theories; yet continued observations would indicate that a grower is not warranted in following either course to the extreme, but rather the medium plan of providing just enough moisture to secure an even, healthy growth all the way through, would seem to be most favorable condition.

An excess of water in hot weather is apt to induce a heavy growth of vine at the expense of early "sets" due to the rank growth, and such succulent growth is also much more liable to succumb to the attack of diseases and insect pests.

Hoeing

Hoeing the hills is of great importance, but it should be done with skill both as to the time and in the manner it is done, for careless hoeing is a common error; if the seed has been properly planted in mellow soil and the irrigation properly applied, there is no reason for deep hoeing in and close to the hill, as it only disturbs the plant and dries out the soil; weeds can be destroyed by rather shallow hoeing.

The dry, cloddy soil on the surface of the hill should be removed and replaced with fine mellow soil drawn up *from away from the hill*, hilling up the plants as much as possible; even to almost covering the two seed leaves. This will protect the plants from wind and insects to a large measure; but the most important feature of this process is the holding of the moisture well upon the stems, affording the best condition for a long base for the development of the roots, as well as supplying the plant with moisture. If, on the other hand, the soil in the hill is loosened up with the hoe and not hilled up by drawing the loosened soil to the plant with the hoe, the hill will usually dry out, and only a short portion of the stem be in moist soil to induce root development.

Cultivation

A thorough preparation of the soil before it is planted to cantaloupes will very much lessen the necessity for so much cultivation afterwards, but a good deal depends on frequent and thorough tillage during the early stages of the growth of cantaloupes; at first it should be deep and thorough, but not close enough to disturb the plants; the cultivations should be more shallow and further from the hills as the plants develop. The grower who cultivates deep and close to the hill because the vines do not prevent this, is cutting off roots, setting back his crop more than he is doing good. He should understand the growth of the roots, for they form the counterpart of the vines on the surface, only they ramify the soil more thoroughly and to a greater distance than the length of the vines, so it is easily possible to damage the crop by careless cultivation. Examinations in the soil between the rows will reveal the tiny rootlets very thick, four to five inches deep, hence surface tillage after the vines start should be the rule; in irrigated regions root pruning seems to be detrimental to the crop.

In the humid areas of the South under heavy rain falls, experienced growers recommend deeper planting and deep, thorough cultivations. They argue that deep cultivation will induce a deep root system, so if the season is excessively wet, the deep stirring will dry out the ground faster, and the root pruning will have the effect of checking the too rapid growth of vines that usually accompanies wet conditions and hot weather, and when, on the other hand, the season proves to be a dry one, the heavy soil mulch will conserve moisture in the subsoil, and the deep root system will permit the plants to develop a good crop, while on the shallow stirred soil the crop will burn up.

Tools Used in Cantaloup Culture

The fourteen-toothed cultivator, with a steel weeding knife bolted across between the two back teeth, so as to run just below the surface an inch or two, has become the most popular tool for cultivating on land clean of alfalfa roots or trash. This gives ideal tillage, and practically kills all the weeds except in the hills.

On alfalfa sod where the crowns would gather on the knife it is not so pleasant to use, yet it will do very satisfactory work, but here the five-toothed cultivator is usually used; this tool is also used to furrow out rows by closing it up and placing a large shovel on the rear shank. When the cantaloupes are "laid by" (cultivated and furrowed out the last time), the irrigating furrows are made somewhat larger than before and they should be "logged out," so that water can make its way through the rows after the vines have covered the ditches; it is also a good plan to lay the vines around out of the furrows once, to train them as much as

Plate No. 7. The Common Tools Used in Cantaloup Culture.

possible away from the furrows; this will keep many of the cantaloupes out of the ditch, though the vines will eventually nearly cover the ground.

A two-horse ten-toothed riding corn cultivator makes a splendid tool for large acreage.

General Care of the Crop

If there is a secret in getting early cantaloupes, it is in growing them from start to finish in such a way that the growth is not checked at any time. The cantaloup does not seem to have the power to rally from a check in growth or an injury of any kind; the setback not only hinders the production of early fruits, but seriously affects the size and yield of the cantaloupes. There are numerous instances where unfavorable conditions of some kind have checked the growth in some part of a field that was planted and otherwise handled the same; invariably that portion of the field will show marked difference in size, netting or other qualities. The best promise of a good crop is a prompt and steady growth from germination to maturity.

The seedling period is the critical time in the development of a crop of cantaloupes, for it is at this stage that the check in growth usually occurs from cold weather, high winds, lack of moisture or the attacks of insects.

A knowledge of the manner of growth of the root system and development of the seedling, will in a measure explain the reasons for the steps taken and the precautions that are necessary at this time in handling the crop through this important period.

The root system that first develops when the seed germinates, penetrates almost directly down from the seed while the stem or radical is pushing its way to the surface. These little roots seem to form a temporary support for the plant during the first two or three weeks, for up to this time the stem from the seed point to the top of the ground is smooth and white, with no evidence of the lateral roots.

The second root system develops from the stem about the time the fifth leaf appears, or four to five weeks after germination; these roots seem to form the main feeders of the plant, for the growth of the plant is almost insignificant until it feels the impulse of this larger and better root system. The question of good early growth and maturity almost hinges on the success of the farmer in supplying the conditions that will favor the early and proper development of this lateral, or main root system. It seems evident that the depth of planting and the manner of managing the soil in the hill has an important relation to the early development of these lateral roots. Experience teaches that seeds planted much over two inches in depth are slow and difficult to germinate, being weakened by the long stem that is necessary to reach the surface; and, on the other hand, if planting is too shallow, the seeds are apt to dry out, or if rain follows a crust will form, which must be removed, and that often exposes the seeds that are not planted at a sufficient depth, with fatal results, or leaves the plant with too shallow a stem support; it is then whipped and wrung by the high, drying winds or exposed to the attacks of the cucumber beetle.

Seed will germinate readily when weather conditions are favorable, if planted at about the depth of one and one-half inches.

When the seed leaves are nearly to the surface the hills should be raked off, removing any crust or dry lumps which may obstruct the little melon plant. Plenty of seed should be used to provide against a loss in handling the hills, or from the attacks of insects. It also affords a chance to select the thriftiest individual plants when the thinning is done. Owing to the injuries from the striped cucumber beetle, the thinning should be delayed until the plants have about the fifth leaf, when the beetle will not do much more injury; the extra plants in the hill should be destroyed by pinching or cutting off the stems, as pulling them out may disturb the plants to be left.

Insect Enemies

No sooner has the seed germinated than the struggle for existence begins; an effectual precaution is to plant plenty of seed scattering it well in the hill, and even replanting before it is evidently necessary—usually some replanting is required anyway. Crop rotation, also, is often a good way of avoiding infested fields, in fact, "prevention is better than cure," in fighting insects and plant diseases.

The destruction of insect harbors, such as weeds, old vines and plants, should be given more consideration, and the cultivation of the fields in the late fall, winter and early spring, will destroy many eggs and insects that pass the winter in the soil—grasshoppers and cutworms, for instance.

The Striped Cucumber Beetle

This little black and yellow striped beetle, about a quarter of an inch long, is doubtless one of the most common melon pests, especially when the plants are young and in the two-leaf stage; long lists of remedies have been tried, but the best that experienced entomologists have to suggest is to spray the little plants as soon as possible with arsenate of lead, at about the usual three pounds to the fifty-gallon formula.

The beetles are not killed by this remedy, but it acts as an efficient repellent. Spraying with the Bordeaux mixture is also recommended, but the Bordeaux is better for the little black flea-beetles when they bother, as they do at times, but they usually work more on the cabbage, radish and turnip. The best means of applying sprays to small plants is the small type of sprayer that can be easily carried over the field, the type that has an air chamber in which pressure is pumped in, and that has a cut-off on the nozzle that works like a trigger, thus allowing the hills to be sprayed with little waste of the material. A very good spray pump of this type is The Brown Auto Spray No. 1, manufactured by The E. C. Brown Co., Rochester, N. Y.

Dusting the hills with air-slacked lime, through a common cheese cloth sack, is an old means of fighting the beetles but is not as effective as the aresenate of lead spray.

The Melon Aphis

The melon aphis is doubtless the most serious pest that the cantaloup has to contend with in many places, and one against which resistance is least effectual where conditions are favorable to the aphis.

Fortunately for the growers the natural enemies of the aphis usually hold them in check quite effectually; the lady-beetle, the Syrphus flies and the lace-winged fly are the principal enemies to the aphis; some seasons a little parasitic fly destroys many aphis.

The only effective measure seems to be a careful watch of the fields to destroy the first plants found to be infected with aphis, as it seems that only a few insects are able to pass the winter, and they seem to spread from a few isolated points, and if these can be destroyed by finding them and burying them, early, this has seemed to be the only plan to adopt, as spraying and fumigation has been tried by the most competent experts with very unsatisfactory results.

Spraying with "Blackleaf 40," one ounce to ten gallons of water, with a little soap, say seven ounces, is the most effective spray where a few hills become infested, but where the whole field becomes infested spraying has proven useless.

The introduction of the natural enemies, like the lady-beetles, has been tried in California with some promise, but this plan is in an experimental stage as yet. The necessity of supplying the enemy as soon as the aphis appears, makes this plan rather impractical for the grower.

Destroying the winter harbor or host

plant of the melon-aphis would seem to be the best measure to adopt, if possible; this winter harbor has not fully been determined for some points.

The Pickle Worm

There have been many complaints from growers in the southern part of the United States of injuries from this worm. Careful inquiry has been made to find the best information on this pest, but there is no known remedy as yet, other than the general precautions of clean farming, rotation of crops and fall plowing; in the more northern melon districts the attacks of this insect are apt to be only periodical, which is true with nearly all insects; they appear in waves; one year they may be very destructive and the next season will hardly be seen, so there is no need of giving up because there have been insect pests one year. The eggs of the larvae of the pickle worm are deposited on the buds and tender shoots of the plants, and as the young worm hatches it feeds in the angles of the stems and leaves, and if the plants were well sprayed with arsenate of lead the first broods would be largely held in check, and subsequent sprays might be profitable.

Plant Diseases

Crop rotation, seed selection, or breeding for disease resistance offer the best means of controlling plant diseases; the spraying of the crop with Bordeaux mixture or other fungicides is about the only other means at hand. In Colorado, spraying has not proven as successful as it is reported to be in other states, doubtless due to different climatic conditions.

Careful control of irrigation seems to offer one means of lessening the attacks of some of the fungus troubles in the arid sections under irrigation.

Harvesting

After all injuries to the crop have been explained and remedial measures suggested, there still remains one great cause of poor returns from the cantaloup crop, viz., *careless and unscrupulous methods of marketing.* When cantaloupes are scarce and sales are quick, there seems to be no power on earth that will stay the hand of the average grower as he pushes his crop onto the market, with the encouragment of advices from his progressive (?) commission merchant; together they have produced a glutted market with inferior products; instead of protecting the markets with a quality that would increase consumption, they simply let it fill up with everything and anything, and neither the grower nor the consumer is benefited. It is common for growers to admit that they are shipping cantaloupes that are not fit to be eaten, and it is not strange that a similar complaint comes from the consumer. Not till the grower is honest with himself, should he expect good returns.

Picking

When green or over-ripe melons are allowed to go onto the markets, the trouble usually is in the picking; careless or mistaken ideas often prevailing. There is a very narrow limit in the stage of ripeness that a cantaloup can be picked and have it in the right condition for distant markets. On one hand, it cannot be picked as green as a tomato or lemon, and still ripen during shipment to fair quality, nor, on the other hand, can it be allowed to show any distinct color of ripeness, like an apple, without it becomes too soft on long shipments.

It should be ripe enough so the flesh will be sweet when cut open, yet too hard to be eaten for a day or two; it requires skill and experience to determine the proper stage.

Jocularly it has been said: "The cantaloup has three stages in three days—green, ripe and rotten." This expresses the fact that there is a very short period for marketing the crop in good condition, yet if picked at the proper stage, and handled right under refrigeration it can be shipped to distant market in quite normal condition.

It is hard to describe to a novice just how to detect the right stage to pick a cantaloup; there is, first, a very slight change of color in the interstices of the netting, hardly enough, however, to attract the attention of the inexperienced; second, it is tried with a pressure of the thumb and forefinger on the stem, when it should "slip," that is, separate in the same manner as when real ripe, but requiring some little force but not enough to break the stem or flesh out; conditions of the vines and climate will at times vary the picker's judgment to some extent; but by occasionally cutting a melon the point can be decided. It is *very essential* that pickers be *carefully instructed*, and *closely watched*, for the good returns should not be expected from green, or over-ripe cantaloupes.

Packing and Crating

The fruit should be carefully handled, not bruised or roughly shaken to loosen the seed cavity; it should be hurried to the shade and crated as soon as possible; the cantaloupes should be carefully graded before crating, not only as to size, but for condition of ripeness, for there will always be some a little too ripe which must not be crated with the green-ripes, or the markets will suffer. In grading, the ripe melons can often be marketed in local or nearby markets, and the ones just right reserved for the long distance shipments.

In crating the layers must be uniform and tight, but not so crowded as to crush or bruise the flesh, yet there should not be a loose melon in the crate if it is expected to carry well.

In crating, the ends of the crates should be supported on the crating table, so that the slats can spring down in the center of the crate, then when the crate is finished and nailed up there will be no spring of the slats to loosen the pack when the crate is picked up.

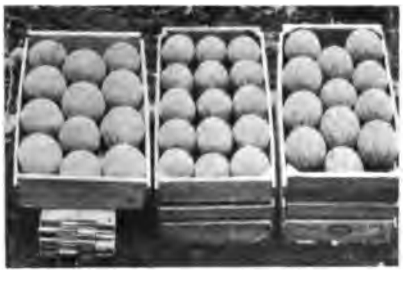

Plate No. 8. Three Styles of Packing.

Plate No. 9. Pony and Jumbo Crates. The basket is used in some sections for local trade.

The crate has been the standard package for a long distance haul, but there is a needed reform in the matter of grading and packing cantaloupes, as the old style grading of "pony," "standard" and "jumbo" sizes has proven unsatisfactory. The standard 45-melon crate is good, but the "pony" has included too many immature cantaloupes, and has not been profitable in general and should be discarded. The "jumbo" crate is too heavy to handle well, and often difficult to crate well, when there are only a few cantaloupes that run to the jumbo sizes.

Three styles of crating cantaloupes are illustrated (Plate No. 8) which will prove adequate to handle the marketable cantaloupes in the simplest way; with only two styles of crates required.

The standard sized cantaloupes would be first crated in a regular standard crate 12x12x24, 45 cantaloupes to the crate, then a size larger packed in the same sized crate with 36 cantaloupes to the crate, packed with what is known as the "diamond" pack—as shown in the halftone (Plate No. 8).

The larger jumbo sizes are then to be crated in a flat, one-layer crate with 12 cantaloupes to the crate. This crate would probably need to be about 5x14x24; this would be easy to handle, and popular for private home trade. With this style of grading and packing, there could be just three classifications, "Standard 45s," "Standard 36s" and "flats" and there would be less bruising, trying to crowd large cantaloupes into crates, and handling large unwieldy jumbo crates, besides simplifying the number of different crates.

Plate No. 10. A Convenient Arrangement for Packing.

Marketing

Marketing a crop of cantaloupes to good advantage is probably the most perplexing phase of the industry; we might classify the different methods of marketing in order to consider them:

First, Selling to the Local Trade—There is little to be said on this, other than the grower already knows, good goods, and fair treatment. *Second, Selling on Consignment*—This seems to be like "stepping out into the unknown," there are so many uncertainties. There are several factors to consider here; the growers should be organized, in order to buy crates and load to advantage, they must take pains to find responsible commission men, they must plan to keep in touch with the markets, to know what the market needs and demands, and live up to their end of the deal in shipping only first-class cantaloupes; they should have some plan of co-operation so that in times of limited markets they could prorate the sales or limit the growers to a certain number of crates to be shipped per acre when the market was glutted, and only a certain amount should be sent to the market, as it is better to leave the cantaloupes in the field than to ship and lose the work and still injure the glutted markets.

Probably the greatest encouragement in recent years for the cantaloup growers is the plan of the cantaloup distributors forming an exchange, and co-operating in holding the markets free from glutted conditions. The plan is to have the distributors in a district get together each day and divide or prorate the shipments to certain markets, and not send to any one market more than it is possible for that market to dispose of; this plan was worked to perfection in the Imperial valley in California, and in the Rocky Ford district the season of 1911, and growers everywhere should refuse to deal with a commission firm who would refuse to co-operate in this way—growers' melons have been used to fight their neighbors too long. *Third, Marketing in Transit*—There are several commission firms who make this a specialty in handling the large shipments from the big melon districts; in reality it does not differ from the commission form of selling, only the organization of a marketing system to keep in touch with the different markets and their needs; this could be handled by a competent manager of a large association if it were not for the short season that the cantaloupes are handled from any one district, the large commission firms having the same organization that they can utilize for other products; hence it is doubtful if there is any better plan than to market through some of the well established agencies. *Fourth, Marketing for Cash*—This is the Utopian idea of the growers everywhere, and as long as cantaloupes are selling well it is all right, but when the price goes down the cash buyer is gone.

Strains and Varieties of Cantaloupes

Rocky Ford

There is a prevalent idea that there is a variety of cantaloup known as "Rocky Fords;" strictly, this is erroneous; unless it is a name to embrace the miscellaneous seed that is purchased from Rocky Ford.

The fact is, the *Netted Gem* was the original variety used to develop the Rocky Ford cantaloup industry, but thirty years of selecting and crossing have developed greatly improved types that are distinct and very different in many respects; but there are really only two or three types; one,—the "Pollock," has been renamed "Eden Gem," "Netted Rock," "Rust Resistant" and so on, and the selection ideals followed by the men exploiting the new names have established slightly different strains of the Pollock. Hence there is a good deal of confusion in regard to Rocky Ford seed.

The markets have a demand for both the *green and salmon-tinted* flesh in the Rocky Ford strains of cantaloupes; this is *entirely distinct* from the orange-colored meat of the *Osage types;* and the growers also demand an extra early strain beside the main crop sort.

Rust-Resistant Pollock, Salmon-Tinted

The original "Pollock" was the result of a hybrid, as running through nearly all the Pollock strains there are the two colors in flesh and various combinations of them — green and salmon-tinted, vine *disease-resistant.*

Rust-Resistant Pollock, Green-Fleshed

The Green-Fleshed Pollock is very similar to the other Pollock, except in the color of the flesh, which runs more green, shading to yellow at the cavity; we would recommend this strain for markets that demand a green-fleshed cantaloup. The general character and appearance of the two strains of Pollock are the same. These two Pollocks are classed as the best late or main crop varieties of Rocky Ford Netted Gems.

The Ryan's Early Watters Strain

There are localities where the early cantaloup is very profitable and there is a demand for an early maturing cantaloup. Ryan's Early Watters meets that demand; this strain holds the best records of high returns on account of its very prolific yields of extra early cantaloupes. In appearance it is almost identical with the Pollock type; it has the green colored flesh, and the same general flavor. The special point in the selection has been *prolific early maturity.* This strain germinates very strong, vigorous plants, the fruit sets early, and the crop matures in a very short time, yet is extremely prolific, often making yields of two hundred and fifty crates per acre. It is fully a week earlier than the Pollock strains. Recommended where the tendency to fungus troubles is not too marked, and for a small portion of a grower's plantings it will doubtless pay in many locations.

Early Rust-Resistant, Hybrid

This strain has a remarkable vigor of growth until it has set and developed a large set of fruit and then the growth seems to stop—that is, the new shoots; the vines seeming to throw all the force into the development of the fruit. This trait seems to make it desirable in one point, as it has not been so seriously attacked by the melon aphis as the strains that have plenty of young succulent shoots.

This hybrid is the best early strain by all odds. It is early as the Watters, and almost as disease-enduring as the Pollock strains; it is very prolific, and especially so in producing a heavy yield of the first early sets.

The flesh of this strain is green, the netting exceptionally good; the cantaloupes are rather inclined to be longer in form than our other strains, and is not quite as regular in size, yet its many good qualities make it the most desirable cantaloup to plant for early.

New Strains of Promise

Triple Hybrid No. 3. This melon has an exceedingly heavy close netting, and thick flesh, of a salmon tint at the center, with a deep zone of emerald near the rind. This cantaloup runs rather large, but on account of its exceptionally attractive appearance, we believe it would be valuable to market growers, especially for local trade.

The Osage type of cantaloup that has been grown for several years around Ordway, Colo., adjacent to the Rocky Ford district, is becoming very popular on the market on account of its exceptionally good keeping quality, and its thick, orange-colored flesh that has an exceptionally spicy flavor which many are fond of. But this variety has the weakness of having a very unattractive form and appearance, and a very undesirable tendency to crack open when nearly ripe, thus resulting in a great loss to growers, and in fact on this account this variety has not been a success except in a few localities.

The following table gives the usual time of planting and the period of harvest for the different districts.

District and State.	Dates of Planting.	Period of Ripening.
Brownsville, Texas	Feb. 10 to 20	May 10 to June 10.
Gainesville, Fla.	Feb. 10 to 20	May 10 to June.
Imperial Valley, Calif.	Feb. 20 to March	May 20 to July 1.
Lake Charles, La.	March 1 to 15	June 1 to July 1.
Northern Louisiana	March 20 to April 20	June 20 to July 20.
Blackville, S. C.	April 1 to 15	June 15 to July 10.
Belton, Ark.	April 1 to 20	July 1 to August 1.
Southern Mississippi	April 1 to 10	July 1 to August 1.
Glendale, Ariz.	April 1 to 20	July 5 to August 5.
Atkoa, Okla.	April 1 to May	July 10 to September.
Decker, Ind.	April 1, in hot beds	July 10 to August 20.
Southwest Arkansas	April 1 to 15	July 1 to August 1.
Moapa, Nev.	April 1 to 15	July 20 to August 10.
Dover, Del.	April 5 to 20	August 1 to 15.
Anna, Ill.	April 5 to 15	August 1 to 20.
Knox Co., Tenn.	April 20 to May 20	July 20 to September.
Greenriver, Utah	April 20 to May	July 25 to August 25.
Eastern Washington	April 20 to May	August 1 to September.
Medford, Oregon	April 10 to May	August 1 to September.
Parsonsburg, Md.	May 1 to 18	July 20 to August 15.
Northwest Arkansas	May 1 to 15	July 20 to August 15.
Rocky Ford, Colo.	May 1 to June 1	August 5 to October 1.
St. Thomas, Pa.	May 10 to 20	August 25 to September 10.
Fredericksburg, Va.	May 10	August 10 to September 1.
King Hill, Idaho	May 10	August 10 to September.
Michigan	May 20	August 20 to September 20.

The above table is tentative.

It will be noted that there is a wide range of differences in the time of ripening when cantaloupes are planted at about the same time, due to the different seasons, the climatic conditions, and the soil, and these same differences make different results in the appearance and quality of the cantaloupes to quite an extent.

PHILO K. BLINN

CANTELOUPES, GRADE RULES. See under ***Apple Packing.***

CANTALOUP DISEASES

Anthracnose

The common anthracnose fungus of the muskmelon (*Colletotrichum lagenarium* Pass.) is the same as that of the cucumber. It attacks the stems of plants of all sizes as well as the leaves, resulting in the lesions of the stem and dead spots in the leaves. In these the fungus produces the fruiting bodies. After the seedling stage is passed it is usually possible to keep the anthracnose in check by the spraying as recommended for cucumbers.

The fruit anthracnose of the muskmelon (*Colletotrichum oligochaetum* Cav.) is widely distributed. It forms yellowish, diseased spots on the fruits and may disfigure them considerable. Thorough spraying with Bordeaux mixture should hold it in check if begun on the young fruits and repeated once or twice at intervals.

Cladosporium

A fungus occasionally parasitic on melons. It produces sunken spots on the fruit and stems, usually during moist weather. Under such circumstances the fruiting stage of the fungus appears over the fruits in an olive green color.

Downy Mildew

***Plasmopara* sp.**

Downy mildew of muskmelon is caused by the same plasmopara fungus as the downy mildew of cucumbers. It does not appear until toward the middle of August, but is then very destructive, sweeping rapidly over the melon fields and leaving only devastation behind. In its attacks the spots of the muskmelon leaves are somewhat different in shape and usually of a darker color than in the case

of the cucumber. One with experience can readily distinguish by the use of an ordinary hand glass. He will then see on the underside of the leaf the violet spores and spore-bearing threads of the mildew fungus. The melons which are unripened upon the vines when attacked by mildew are practically worthless and for this reason large losses are usually incurred. The treatment is by Bordeaux mixture.

Muskmelon Leaf Blight

Alternaria sp.

Is a disease more or less peculiar to the muskmelon, although the fungus which causes it has also been found upon cucumber leaves. The leaf blight causes rather large dead areas in the leaves which are usually distinguished from those of downy mildew by their larger size and the tendency of the central portion to break out. The prevention of muskmelon leaf blight is by no means an easy matter, requiring of itself great thoroughness and carefulness in the application of the Bordeaux mixture and also requiring that the downy mildew shall be watched during the same period. For this reason earlier sprayings, if made before August 1st, should be repeated at fortnightly intervals, while those after August 1st should be at weekly or 10-day intervals. Melon growers have succeeded by following these lines, while others who were less thorough were less successful, or failed entirely. The treatment is recommended with confidence.

Wilt

Muskmelon wilts are the same in general character as those described for the cucumber. Not only the bacterial wilt disease but the wilt due to fusarium has developed upon muskmelons in some parts. The symptoms are the same as for cucumbers, namely: sudden wilting as from lack of water, followed by dying.

Gather and burn infected vines and practice rotation.

Root Rot

Rhizoctonia

The root diseases accompanied by rotting of the rootlets and induced by the sterile fungus of lettuce rosette is also found on greenhouse muskmelons. This is liable to be the case where these follow diseased crops of lettuce. The prevention is thorough soil treatment.

A. D. Selby,
Wooster, Ohio.

For other diseases affecting cucurbitous crops, see *Cucumber*.

CANTALOUP PESTS

Cantaloup Fly

Euxesta notata Wield., Family Ortalidae

General Appearance

The adult flies are slightly over one-eighth of an inch long, beautiful metallic green in color with eyes dark brown. The wings are transparent with a distinct black spot near the middle of the front margin and a similar spot near the tip of each. The maggots vary from white to dusky brown, the blunt end being often darker than the rest of the body. They are about one-fourth of an inch long when fully matured.

Life History

The eggs are laid in the tissues of injured or damaged fruits and vegetables and while the maggots work principally upon such tissue they are often found in sound and living portions and occasionally in apparently uninjured fruits. The pupae are found in the decayed hosts or in the soil, the adults emerging in a very short time. Due to the peculiar habits of the larvae, they have often been mistaken for the maggots of the true fruit flies of the family *Trypetidae* and have been the occasion of great alarm.

E. O. Essig

White-Lined Sphinx

Celerio lineata Fab., Family Sphingidae
Deilephila lineata Fab.

General Appearance

This is a very common insect. The adult moths are quite large, having a wing expanse of nearly three and one-half inches. The fore wings are green with broad brown bands on the front and apical margins and in the middle of each. The veins are white. The hind wings are very small, dark brown with a wide lighter band across the middle of each. The thorax is grayish with distinct white lines, while the abdomen is dark green marked with black and white spots. The larvae are quite large, often more than three inches long. The color varies considerably, but is usually light green with a row of spots along each side of the back. The spiracles, just above the feet, are margined with black and yellow. A pale yellow line extends down the middle of the back. The chrysalis is dark brown.

Food Plants

The larvae of this species are so common as to be often mistaken for other members of the family. They are usually found feeding upon the foliage of the apple, grape, pear, melon and tomato vines.

E. O. Essig

Melon Aphis. See under *Aphids.*

For other pests of cantaloup and other cucurbitous crops, see *Cucumber.*

Capillarity in Different Types of Soil. See *Soils.*

Carlots, Cities in Which Fruits are Sold in. See *Reduction of Waste in Marketing,* market section.

Cars, How Diverted. See *Reduction of Waste in Marketing,* in market section.

Carlot Markets. See *Reduction of Waste in Marketing,* in market section.

Carob

The carob tree (*Ceratonia siliqua* L.) is a native of the Eastern Mediterranean countries and is widely grown in Italy, especially in the southern part of the peninsula and in Sicily, because of the value of its pods as food for domestic animals. The tree attains a large size, sometimes reaching a height of 50 feet, and in shape is much like a live oak. The heavy dark green foliage, composed of thick, leathery, rounded leaves arranged on each side of a stem, as in the common locust, affords an abundance of excellent shade in hot weather. The tree resists drouth and grows readily on rocky hillsides where it is impossible to irrigate and where the soil is poor and scarce. At the same time, it is appreciative of good rich soil, and grows larger and more symmetrical under favorable conditions. The bark of the carob is rather smooth on the larger limbs, and light gray in color, but on the smaller branches, that is, those which are from three to five years old, there are numbers of roughened knots, giving these branches a diseased appearance. But on examination it will be found that all the pods are borne on these branches, and that the knots are the places where the fruiting stems of the previous year or two were attached. These stems fall off with the pods, and the knots disappear in the course of two or three years.

The fruit of the carob, as I have said, is in the form of pods, very similar in appearance to bean pods, and called by the Germans St. John's bread. In the spring the young pods, hanging in clusters from the branches, look exactly like string beans, being of the same shape and color. Later they become broad like the pods of lima beans and when ripe they are broad and flattened and are two or three inches long and nearly an inch wide. By this time they have become a dark chocolate color and consist of a rather soft shell, nearly filled with a reddish, saccarine flesh, imbedded in which are a number of dark red, flattened seeds. The ripe pods are heavy, and contain about 65 per cent of gum and sugar, making excellent food for sheep and hogs, particularly when it is desired to fatten these animals. They are also fed to cattle and horses at the rate of about six pounds a day, the pods being crushed and fed either raw or boiled. The seeds germinate readily if fertile, but there must be a number of trees growing near each other and bees must be plentiful to insure fertility. In Southern Italy and particularly in Sicily, the pods are used as food by the people, and the children among the lower classes eat them as they would candy. The ripe pods are either boiled or roasted, and are sold on the streets everywhere, where one may buy a dozen or more for a cent. They have a sweetish, slightly bitter taste, and are somewhat astringent. In the cooked state they are undoubtedly healthful and very nourishing.

The carob tree is one of the necessities, almost, of the average Italian farmer. It gives him and his stock ample protection against the hot summer sun; its pods are food for the animals, and for himself as well, if necessary; and it does not demand rich soil. It is most frequently planted where little else will grow, in rocky land or about the edges of gardens or olive groves, and with its sturdy form and thick, heavy leaves it withstands perfectly the hot dry Sicilian summers.

E. J. Newcomber,
In the California Cultivator.

Carrots

The carrot grows wild in the fields and on the roadsides of Great Britain and the seashores of the North Temperate zone of the Old World. It resembles the cultivated carrot, except in the root, which is thin and woody. However this wild carrot is the parent of the cultivated varieties.

Carrots vary considerably in the length, shape and color of their roots, and in the proportion of rind to core. The White Belgian, which gives the largest crops, has a very thick root which is white, becoming pale green above, where it projects above the ground. For nutritive purposes, it is inferior to the red varieties. The carrot succeeds best on a light sandy soil, which should be well drained and deeply trenched. If not naturally fertile the ground should be well prepared and heavily manured, in the autumn or winter. For the long-rooted sorts, the soil should be at least three feet deep; but for the shorter rooted varieties a soil of less depth is sufficient.

Growing Carrots

For the early crop sow the seed as early in spring as the ground can be worked in rows 10 to 12 inches apart if hand cultivated, and 18 to 24 inches if cultivated with a horse. About two pounds of seed are required per acre. Cover the seed about one inch deep. It is advisable to mix in a few radish seed to help locate the rows, since the carrot seed germinates slowly, and cultivation to keep down weeds is frequently necessary before the young carrots make their appearance. When the plants are well up they should be thinned to stand two to three inches apart in the row. Frequent shallow cultivation should be given with some light implement throughout the season. Late varieties for stock may be sown the latter part of May or as late as the middle of June in the Northern states. The plant makes its best growth in the cool weather of fall.

The crop is harvested usually by hand pulling and topping. The work of pulling is often facilitated by running a plow alongside the rows to loosen them. Where the half-long varieties are grown they can frequently be plowed out. From 200 to 300 bushels per acre is a good yield. The roots may be stored in pits or in the cellar like potatoes. There is a considerable amount of hand labor in the culture of carrots, which makes their growth relatively expensive.

Besides the use of carrots as a table vegetable they form a favorite succulent food for horses and dairy cows. Foreign experiments show that for stock feeding purposes carrots are about equal to other roots. The agricultural experiment stations in this country have reported but few experiments with this crop as a stock food. Except for the purpose of variety in the diet it will probably be economy to grow other larger yielding root crops, like mangels and rutabagas.

Granville Lowther

Carrots in Alaska. See *Alaska.*

CARROT DISEASES

Leaf Spot

(*Cercospora Apii* Fres.)

Same fungus as causes celery leaf spot. See under *Celery Diseases.*

Root Rot or Rhizoctoria

Corticium vagum B. & C. Var.
Solani Burt.

Same as potato root rot, which see.

Soft Rot

Bacillus carotovorous Jones

One of the commonest bacilli parasitic upon plants. It produces a soft rot on many vegetables. Avoid planting infected seed and planting in infected soil.

CARROT PESTS

Carrot Beetle

Ligyrus gibbosus, Dej.

Common along the Atlantic coast and occurs as far west as Illinois. Called also the sunflower beetle on account of its attack on this plant. It is injurious to parsnip, celery and sweet potato.

The beetle is one-half to five-eighths of an inch long and robust.

Rotate the crops, permit the chickens to follow after the plow in the fall and in case of severe infestations, turn the hogs into the field.

Literature

Division Entomological Bulletin No. 33, New Series.

Carrot Rust Fly

Psila rosae Fab.

Imported into Canada, whence it has spread into New York. A very minute fly measuring about one-sixteenth of an inch. Produces a reddish appearance on the leaves of the young plants and rusty blotches on the roots. The stored roots are sometimes infested with the larvae.

Rotation of crops is advised, but the same fly attacks celery, hence this plant should be excluded from the rotation.

Spray with kerosene emulsion one part to 10 of water, or sprinkle sand, ashes or land plaster mixed in the kerosene along the rows. Make these applications once a week through June.

Literature

Division Entomological Bulletin No. 33, New Series.

CELERY CATERPILLAR. See under *Celery*.

PARSNIP LOUSE. See under *Parsnip*.

CATCH CROPS. See *Apple Orchard Cover Crops*.

Cauliflower

The cauliflower belongs to the cabbage family and was introduced into Europe from Cyprus and the Mediterranean coast. It is one of the most delicately flavored of vegetables and is much more delicate in its growth than the cabbage. It is less resistant to heat and cold, and requires more care than the cabbage; but under proper conditions, is one of the most valuable of vegetables, bringing a good price in the markets. It forms a dense cluster of incipient flower buds which are the edible portion of the plant. It succeeds best in a rich soil and sheltered position. It is propagated like the cabbage and given similar care; except that when the head begins to form, the large outside leaves should be pulled over it and fastened together at the top in order to prevent injury from the hot sunshine.

As a crop, they ripen somewhat irregularly and, as the period of frost approaches the immature heads should be pulled with roots and leaves and be planted in a cold cellar or cold frame where many of them will form salable heads.

There are many varieties; but perhaps the most desirable are the Snowball and Early Dwarf Erfurt.

The insect enemies are the same as those of the cabbage.

Being of the same nature as the cabbage, and requiring similar treatment, we refer our readers to the article under that heading.

GRANVILLE LOWTHER

CAULIFLOWER DISEASES

For the most part cauliflower is affected by the same characteristic diseases as cabbage. They will be found treated under cabbage.

Ricing

This is not a disease but is a trouble caused by the starting into growth of the flower heads, usually after a rain following a dry spell. It injures the appearance but not the quality of the head.

The trouble is corrected by cultivation so as to preserve a good dust mulch during dry periods.

Soft Rot or Stump Rot

Bacillus carotovorous Jones

A common soft rot of vegetables and a most serious one to cauliflower, appearing at its worst in seasons of hot, damp weather. The bacillus is a wound parasite but the manner of its spread is unknown. It spreads very rapidly at times. The center of the stem and head usually rot first so that the plant may be beyond recovery before the presence of the disease is detected. The odor arising from the decaying heads is very repulsive.

Rotation seems to be the only remedy.

Literature

Cornell Bulletin No. 292.

CAULIFLOWER PESTS

The pests of cauliflower are common to the cabbage and will be found treated under cabbage.

CAULIFLOWER, HOW GROWN IN ALASKA. See *Alaska*.

Celery

More and more celery is growing into favor as a garden vegetable. It grew wild in England, beside the ditches, in marshy places, in swamps, especially near the sea, producing a furrowed stalk, with compound leaves and wedge-shaped leaflets. In its native state, the plant has a coarse, rank taste and peculiar smell.

By cultivation and blanching the stalks lose their acrid qualities and assume a mild, sweet, aromatic taste peculiar to celery as a salad plant.

Propagation

Celery is grown from seed, sown either in a hotbed or in the open garden, according to the season of the year, and after one or two thinnings out and transplantings they are, on attaining the height of six or eight inches, planted out in deep trenches convenient for blanching. The blanching process is one of the most important in the production of celery, and consists in "earthing up," or drawing the earth around the plant to exclude the light.

Soils Best Adapted

Celery is a native of the swamps, generally adjacent to the sea. Since the draining of the swamp lands near the Great Lakes, large areas of those sections are adapted to the growing of celery. In this industry perhaps Michigan takes the lead. However, in the arid regions, where irrigation is practiced, celery can be grown anywhere and the soils too wet for most other crops, and too strong in alkali, may be used for the growing of celery, and in this manner the "seepage lands" utilized for a very profitable crop. Celery has been successfully grown on lands that in the winter were white with alkali.

GRANVILLE LOWTHER

For CULTURE IN ALASKA, see *Alaska*.

Growing Celery in an Irrigated Section

*J. L. Reid, Colorado Experiment Station, writes as follows:

Varieties

In commercial growing only two varieties are being used at the present time to any great extent. These are the Golden Self-blanching for the early market, and Giant Pascal for the late market. These supply all that the present market requires, for by proper methods, Golden Self-blanching can be put on the market from early August until the Giant Pascal is ready and this latter can be held as long as it is profitable to keep it in storage. The Golden Self-blanching is not as crisp and tender nor of as good quality as the Giant Pascal, but owing to its earliness, the ease with which it is blanched and the fact that so much more can be grown to an acre, it is far the more important in respect to the amount grown. Pascal celery does not come onto the market until about the first of November and we are entirely dependent on the self-blanching up to that time.

Seed

Most of the seed is procured from American dealers, but the growers nearly always ask for French grown seed, because in that country the seed is usually more carefully selected. A few growers have sometimes grown their own seed and obtained excellent results by its use. Sometimes a grower will raise enough seed one year to last him several seasons, preferring to do this rather than use seed bought from unknown sources. Owing to failures as the result of poor seed, the use of home grown seed would be more than justified, even though it cost more.

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* Bulletin 144, Colorado Experiment Station.

Vitality of seed is quite variable, so it is impossible to figure the number of plants which may be procured from a given amount. It is estimated in buying seed that one can count on 2,500 plants per ounce of seed, but this is very conservative, for some growers get as high as 25,000 stocky plants per ounce when they have good seed. The number of plants suitable for planting depends upon the vitality of the seed and the care of the grower. It is the practice to sow enough seed to secure more plants than will be needed and then select the best of these. Very often a surplus stock can be sold at a good profit, and it is also advisable to have extra plants for resetting in case of damage to young plants by drought or hailstorm.

Raising the Plants

Celery seed is very slow in germinating and sometimes great difficulty is experienced in getting a good stand of plants. Here is where the gardener must ever be on the alert. The seed bed and young plants must never be allowed to become dried out, and yet water must not be allowed to stand on the surface. The young plants are very tender, and a fine spray should be used in watering them. The seed is sown broadcast in the beds or sometimes in very shallow drills four or six inches apart. The seed should be covered very lightly, if at all. Germination will take place in about three weeks.

The Golden Self-blanching celery is usually sown between March 1st and 15th in mild hotbeds from which have been taken one or two crops of radishes or lettuce. These beds are made with about one foot of manure, over which is spread between six and 12 inches of soil, and the whole is covered with glass sash. By the time one or two crops of lettuce have been taken from a bed, the manure does not give a strong heat, but just enough to protect on frosty nights. If one desires this celery for the August market, it is quite necessary that some artificial heat of this sort be given the seed bed, but fresh beds should be used only with great care or the plants will not be strong. For later sowing of the seeds, frames simply covered with sash may be used.

The Pascal celery is mostly sown between April 1st and 15th in frames under cloth, although a great deal is sown in the open ground. The advantages of growing under cloth are that the soil is kept from dying out and the young plants are protected from extremes of temperature. It is not considered profitable to transplant celery, so it is left in the original beds until ready for setting in the field, although much more stocky plants may be secured by giving an extra shift.

When the plants are grown in hotbeds, as many as 8,000 are sometimes raised under a three by six foot sash. However, when less expensive beds are used, it is better to use more room, as one thus gets far stockier plants. Many growers sow one-fourth ounce of seed to one sash three by six feet, but this crowds the plants somewhat. It is very important that the plants be carefully "hardened off." This is done by gradually getting them accustomed to the wind and sun. The sash is raised more and more each pleasant day until the plants can stand to be entirely uncovered. It is very important that they should never be allowed to become cold enough to be frosted as this no doubt is one of the principal causes of going to seed.

Several methods are in use for making the plants stocky. Transplanting has already been mentioned, but this is an expensive process. Clipping the tops off lightly once or twice while in the beds is practiced to quite an extent. A few growers have a knife so mounted on wheels that it can be run under the plants, so as to cut off the tap root, thus causing more side roots to develop.

Setting of Plants in the Field

When the ground has been thoroughly prepared and danger of frost is over, the plants may be set in the field. If an early crop is desired it is, of course, necessary that the plants be set early, so as to give them as much time as possible to get their full growth. If the plants are crowded in the seed bed, it is a good practice to thin them and use the plants removed for the first setting. This gives the remaining plants a better chance.

A small furrow is made and the irrigating water is turned into it. This settles the soil and puts it in good condition for setting the plants. After the water has seeped out of the ditch it is the plan of most growers to run a small stream into the furrow again. The surface of the water this second time leaves a line along the edge of the furrow and the plants are set along this line, thus making them all at the same level. In this way none of the young plants are covered when irrigated, and yet all are close to the water. Where self-blanching is grown, a row is set on each side of the furrow, making two rows about 12 inches apart. Where Giant Pascal is raised, plants are set only on one side of the furrow, and that on the south side if the furrows run east and west, so that the plants may escape the reflection of the sun's rays from the water. The furrows are made about four feet apart. The plants are set from six to eight inches apart in the row. With single rows four feet apart, plants eight inches apart in the row, 16,710 plants would be required per acre; with plants six inches apart in the row, 21,780 plants would be used per acre. When self-blanching is grown in double rows, just double this number of plants would be used. It is well to have an abundance of plants so that later on any vacant places may be filled.

The beds are watered very thoroughly before removing the plants for setting, and then the plants may be pulled out singly by the roots if it is desired to thin the beds somewhat. The plants are arranged in bunches which can be held conveniently in the left hand. They are put in a box over which is thrown a wet sack to protect from the sun while being carried to the field. In setting, some simply lay a plant on the first finger of the right hand and stick it into the mud on the side of the furrow; others, where the soil is heavier, make a hole in the soil with a pointed dibble held in the right hand and place a plant in the hole with the left, the dibble then being stuck into the soil beside the plant to close the hole. It is a good plan to wet the roots with puddled mud just before starting to set a handful. There is quite a knack and a whole lot of hard work in setting, but it can be learned much more quickly by watching a good workman and by doing it oneself than by reading how to do it.

Cultivation

Since celery is transplanted to fields which are clean of weeds, the plants have the start of the weeds. However, it is generally necessary to give one or two hand weedings. A wheel hoe is used once or twice, and four or more cultivations are given with the horse and a harrow-tooth cultivator in the wide spaces. Some make a practice of cultivating once a week during the growing season. Those who blanch with dirt often use a five-tooth cultivator the last time or two, so setting the teeth as to throw some dirt toward the rows.

Irrigation

Concerning irrigation, each grower has his own ideas as the result of his experience under his particular conditions. Some do not irrigate more than two or three times during the season. Others irrigate nearly every week, commencing at the time of setting. On sandy, well-drained soils it is necessary to irrigate very often. One must use his own judgment, always remembering that celery grows in swamps in its natural condition and, therefore, cannot stand drought.

During the growing season the water is run in the furrows which were made at the time of setting the plants. If double rows are used, as soon as the crop has a good start this furrow will be completely hid by the tops of the plants, but the water will still follow the ditches in good shape if they have been kept clean of weeds. Since the ditch at this time is shaded by the plants, the soil dries out less rapidly and does not bake so badly.

Blanching

Blanching consists in so excluding the light that tender stalks free from coloring matter may be obtained. Self-blanching varieties for the early market are blanched entirely with boards. The banking of celery high with earth during the hot summer days sometimes hurts the crop. Blanching with boards keeps the celery cleaner, but is quite expensive, owing to the great cost of lumber, so it is generally practiced only for a part of the early crop. Boards 12 to 14 inches wide by any convenient length, usually 16 feet, are used. It takes about 20,000 feet of lumber to blanch an acre at one time, but since during the warm part of the year the blanching will be completed in about three weeks, the boards may be used to blanch a second lot. If the boards are carefully piled each year so they will not warp and are protected from the weather in some way, they will last many years. Some use wire hooks to hold the boards together instead of using stakes.

By far the largest part of the crop each year is blanched by means of earth. One horse is used on a celery hiller, which runs between the rows and throws the dirt against the plants. It is generally necessary to run this machine through twice in order to do a good job, and sometimes two horses must be used tandem to pull the hiller. Some growers like to finish the earthing with shovels or hand tools, but this adds to the expense. The celery hiller has iron rods so fixed as to lift the leaves out of the way so they will not become covered with earth. About four weeks are necessary for blanching with earth in the field.

For later use a great deal of celery is left to grow in the field as long as there is no danger of frost, and then removed to trenches for blanching. Giant Pascal is either blanched in this way or is partly blanched in the field by means of "papering," and then removed to the trenches. A great deal of self-blanching is also blanched in trenches. The celery is removed from the row, without trimming the roots too closely, and put into long, narrow trenches, so that about two-thirds of the plant will be below the level of the ground. From 12 to 18 inches is as wide as the trenches should be made, for. if too large quantities are stored together, there is danger of loss from heating. The tops of the plants are covered with light material only as there is danger of freezing. When extreme cold weather comes, earth must be used for protection. Careful watch must be kept to see that the celery does not spoil from being covered too deeply, and yet, if it is allowed to become frozen to any great extent, it will be unsalable. As soon as the plants are set in the trench, water is turned in and a thorough irrigation is given. This will usually furnish enough moisture for the crop until it is ready for the market. If, as is often the case with Giant Pascal, the celery is not dug until late and is to be kept far into the winter, a second or a third irrigation may be necessary in dry seasons.

There is a limited market for "papered" Giant Pascal celery. By this is meant the wrapping of each plant in paper during the latter part of the growing season. This work is commenced in August, and boys are usually hired to do it at two and one-half cents per dozen plants wrapped. Old daily papers are used, and one string holds the paper in place. It is important that this work be postponed until the celery is high enough so that the tops of the leaves will be above the paper after wrapping. Old papers can be bought for $8 or $10 per ton. As soon as there is danger of frost the celery is dug, put in trenches, and handled in the same way as the other; but has however the advantage of being cleaner and is already partly blanched.

Storing

Since the California and Florida crops get onto the market during the winter and spring, it has not been found profitable in northern sections to store celery for any great length of time.

Harvesting and Marketing

Where only a small area is devoted to celery, the plants are usually loosened from the ground by means of a spade. The roots are cut off and the plant is laid to one side. Where the acreage is larger, especially where soil is used entirely for blanching, a celery digger is used. Different styles of home-made machines are being used for this purpose, but the principle of them all is to run an edged tool just under the plant, thus cutting off the root so it can be taken up by hand.

Golden Self-blanching celery is usually "shipped in the rough." A few of the outside leaves are removed and the celery is packed directly into crates. The number of dozen plants in the crate is marked on the outside, the side of the crate is nailed, and the crate is ready for the car. These crates are usually 20x22 inches by 24 inches deep. The top is entirely open, except for a strip along each edge. When celery is to be packed for "shipment in the rough," one of the other sides is left open so that the plants may be packed in from the side. The remaining side is then nailed on and the celery is thus held securely in place. A crate will hold from four to seven dozen of celery, according to its size at the time of marketing.

Celery Growing in a Humid Section

*C. P. Halligan, of the Michigan Experiment Station, makes the following suggestions on celery culture for that section:

The distance to plant celery depends much upon the variety, season, methods of blanching and intensiveness practiced. Where celery is to be blanched by boards, the rows may be set from 18 inches to three feet apart while celery which is to be blanched with soil is commonly set from four to six feet apart. At Kalamazoo and Muskegon, where early celery is grown, the first planting is set in rows about three feet apart and the second crop is planted later between these rows. Sometimes only every alternate row is thus interplanted at first but a late crop is afterward set in the vacant places. This will leave a space of six feet for blanching the last crop with soil. When a summer crop is grown alone and the celery is to be blanched with boards, the rows are set from 18 inches to two feet apart. In other sections, where land is less valuable and the culture less intensive, the rows are planted from three to four feet apart thus permitting horse cultivation. In outlying sections, where larger areas are handled, the cost of production will be less if planted at about this distance.

The distance the plants are set in the row is also more or less variable but three plants to a foot is the general rule in this state. Giant Pascal and other large growing varieties are usually set six inches apart while some growers even prefer a space of eight inches for this variety.

Table of Plants Required per Acre

Distance between rows	Distance between plants	Number of plants	Lumber required for blanching
18 inches	4 inches	87,000	58,000 sq. ft.
2 feet	4 inches	65,240	43,500 sq. ft.
3 feet	4 inches	43,560	29,000 sp. ft.
4 feet	4 inches	32,670	21,750 sq. ft.
5 feet	4 inches	26,136	Earth
5 feet	6 inches	17,424	Earth
6 feet	6 inches	14,510	Earth
6 feet	8 inches	10,881	Earth

One ounce of seed should produce at least 10,000 plants.

Cultivation

Celery must be kept continuously growing if stalks of high quality are desired. Although an excessive feeder, demanding plenty of plant food and moisture, the plant has a very shallow root system. Therefore, constant but shallow cultivation is absolutely required to produce good crops. As soon as the plants are set in the fields, the rows should be cultivated, being especially careful not to throw any soil over the hearts of the plants. Hand hoeing may be necessary between the plants. Cultivation must be then given after every rain and as often otherwise as it is necessary to maintain a fine dust mulch over the soil. This will prevent the moisture of the soil from passing off into the air and in addition to keeping the roots well supplied with water, it will prevent the roots from working deeper into the soil where the supply of air is not so plentiful and the production of plant food not so rapid. Constant cultivation induces a larger and better quality of growth by preserving

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* Bulletin 60, Michigan Experiment Station.

the soil moisture and keeping the roots near the surface where the plant food is liberated more rapidly.

As the surface of the soil in cultivating should not be thrown up in ridges but kept as smooth and fine as possible, a small-toothed cultivator should be used in preference to the larger shovel tooth types.

About the Kalamazoo section, the crop is planted in rows too close to permit horse cultivation and the fields are worked with hand cultivators. These are especially desirable for cultivating the crop as they permit stirring the soil very close to the plant without danger of injury by deep cultivation.

Marketing

The marketing of the celery crop starts in this state about the first of July and continues more or less steadily until midwinter. The harvesting season of the various celery districts in Michigan come at such times that one district does not enter into serious competition with another in the general markets. The Kalamazoo, Muskegon and Grand Haven districts, for example, grow early celery, starting their marketing about the first of July and continue until some time in October. Even these sections hardly compete with each other, as the Grand Haven and Muskegon crops are shipped across the lake to Chicago, or Milwaukee, while the Kalamazoo crop is sold largely in other cities, being expressed to points all over the United States. During the fall, the other districts, at Decatur, Vriesland, Hudsonville and other smaller sections where the crop is grown more extensively, begin shipping and aim to dispose of most of their crop before severe freezing weather. A small portion of this crop in these districts is trenched in the field, but is generally disposed of before mid-winter when the California product enters the market.

Harvesting

Celery may be harvested as soon as it attains the proper size and is well blanched. With the earliest crop, to gain the advantages of a high market, it is frequently cut slightly before this time and it often pays better under these circumstances than to wait for the crop to fully blanch and mature. If the plants are left too long after they have matured, they lose their crispness and flavor and are apt to become diseased.

When the crop is harvested during the summer months and is to be shipped long distances, the plants should be cut and carried to the packing shed early in the morning. In the Kalamazoo district, this work is all performed before 7 o'clock in the morning. The boards used for blanching are removed only as fast as necessary and laid between the rows to serve as a walk. If the plants are left exposed to the sun and wind, they lose their firmness and are apt to wilt, hence the boards are removed only as fast as the celery is cut. Using a stiff knife or spading shovel, the roots are cut a short distance below the surface of the soil and the plants laid in small piles along the boards. As the packing shed is generally nearby, wheelbarrows are used to gather the plants as fast as they are cut, and they are carried at once to the packing house. Where this building is more distant or the operations more extensive, wagons are used and the plants covered with canvas on the way to the packing house.

After reaching the packing house, the plants are trimmed by removing the outer leaves and cutting the roots to a more or less conical shape with a flat point near the base of the plant. They are then thoroughly washed in clean cold water which helps to keep them in a firm, fresh condition. After being allowed to thoroughly drain for some time, they are tied into round bunches containing 12 good sized plants. In early July, when the plants are rather small, 13 or 14 of them are sometimes necessary to make a good sized bunch.

Generally the only grading practiced by the growers consists in discarding the smallest plants or "culls" and bunching all the marketable sized plants together. Some growers practice more rigid grading, selecting the largest and best plants, bunching separately and shipping these to a special market. The smallest plants are sold locally and seldom pay to pack and ship.

In bunching celery, a board about a foot long and eight to 10 inches wide is nailed along the upper edge of the packing bench, with a semi-circular piece cut out along the upper side of it large enough to hold the bases of 12 good sized plants which, when placed in it can be quickly tied into a round bunch. Extra stout white string is used, making one tie around the base of the plants and one near the tops.

Many of the more careful packers of summer shipments are now wrapping each bunch separately, with heavy brown paper, using open crates. This tends to prevent the heating of the celery in long shipments during hot weather and will undoubtedly be used more as its advantages become appreciated. However, most of shipments are made in tight crates which are lined with heavy wrapping paper. The size of the several crates used varies considerably throughout the state but the following is a list of the common sizes used at Kalamazoo:

Sizes of Kalamazoo Celery Crates

Inches
6x 8x24
6x10x24
6x12x24
6x16x24
6x18x24
6x20x24
6x22x24

Inches
6x24x24
6x26x24
6x28x24
10x16x24
10x18x24
10x20x24
10x24x24

10x26x24

In the other celery districts of the state the crates are quite different in form and the celery frequently packed loose in the crates. The following are the sizes genrally used:

Inches
6x12x20
6x12x22
6x18x22

Inches
10x10x18
10x10x20
10x10x22

At Decatur much of the crop is shipped in the rough. When shipped in this manner some of the roots are left on the plants and only a few of the outside leaves removed. The celery is then packed in large open crates, being trimmed and bunched in the storage houses of the cities by the commission dealers before being delivered to the retailers. Shipping in this manner enables the growers to handle and ship their crop while the weather is favorable and the crop is placed in a fresh, crisp condition upon the market.

Storing

Although most of the celery in Michigan is sold before freezing weather, about Hudsonville, Vriesland and some other sections, large quantities of it are stored for early winter. Many market gardeners about the cities of the state dealing with a special or local market also store this crop.

When the crop is to be sold in late fall it may be simply banked as high as possible with soil and the tops covered with straw, to protect the plants from light freezes. Celery that is to be stored for early winter is usually trenched. This consists of digging a trench about a foot deep in the field between the celery rows, into which the plants are closely set, so that the tops are not more than two inches above the ground. The trench may be dug by hand or by plowing out a double furrow, and the plants should be lifted from the rows while the foliage is dry, with some soil clinging to the roots. A protection of some sort must then be provided. When blanching boards are at hand they may be nailed together in a V form and placed over the trenches. If the weather then turns warm after trenching, they may be slightly raised with blocks or stones, for ventilation. As it gets colder a light furrow of soil may be turned against the base of the boards, and later, the boards covered with manure to protect the plants. If boards are not available the plants may be covered with hay or straw, until danger of severe freezing, when they may be further protected with manure.

The storing of celery in this state for late winter is generally unprofitable, and hence it will seldom pay to erect a celery storehouse for this purpose. Storage pits, vacant hot beds or cellars are often satisfactory for storing this crop. In fact, it may be stored in any place where the plants may be kept cool and moist, without danger of freezing and where thorough ventilation may be given, especially during warm weather.

Diseases

Celery as grown in Michigan is not as susceptible to injury of fungus diseases as in many other sections of the country. The comparatively cool, moist days of the growing season are especially favorable for the production of healthy, vigorous plants, but in seasons that are unusually warm, these diseases often become very injurious and sometimes ruin entire crops.

Damping-Off

Rhizoctonia

This is the most serious disease of the celery plants while in the seed bed. During the first two weeks after the seedlings appear, it is especially apt to attack the plants. This disease causes a decay on the main stem or root just at the surface of the soil, which quickly kills the young seedling. During warm moist weather it is apt to be very injurious, spreading rapidly throughout the bed. In the greenhouse, too much heat, lack of ventilation, and watering the plants on dark cloudy days, or late in the afternoon, all tend to promote this disease. Thorough ventilation, plenty of light, judicious care in watering, in general, keeping the plants on the "dry side," tend to prevent this disease.

Early Celery Blight

Cercospora apii

A common disease of celery infecting the foliage early in the season. It first appears as well defined spots on the leaves that soon become so numerous as to cause the leaves to turn yellow and finally die. On the dead leaves the disease multiplies very rapidly and soon spreads to the other plants. It does not generally appear late in the season, but plants weakened by this disease are often afterwards attacked by the late blight. Spraying the plants with Bordeaux mixture, as recommended for the late blight will control this disease, the early spraying being especially important.

Late Celery Blight

Septoria petroselini

Of the diseases affecting celery this is generally the most common and serious one. It first appears in late summer or early fall as irregular rusty brown spots on the outside leaves, spreading under favorable conditions over the entire leaf surface and to other leaves of the plants, causing a burned appearance to the foliage in a very short while. During unusually warm, moist weather in the growing season, or after the crop is stored, this disease proves very destructive. Plants set upon poorly drained land or plants stunted or weakened by any other means are especially susceptible to it. If the plants are kept growing vigorously and well cultivated they are not as susceptible to it, and are generally able to withstand its effects. However, when the blight has become well established upon the plants it is then too late to apply effective remedial measures. The disease may be prevented also by spraying the plants with Bordeaux mixture,* using the 5-5-50 formula, or the ammoniacal carbonate of copper spray, beginning when the plants are small, spraying once before lifting them from the seed beds, and continuing the spraying every ten days or two weeks until the plants are ready to blanch by boards. The success of this work will depend largely upon the thoroughness with which the foliage of the plants is covered, as it is important that all portions of the plant be reached by this spray. All diseased plants and refuse left in the field after harvesting should be carried from the land, rather than to turn it under with its spores of this disease to cause another infection the following season. When conditions will permit, rotation of crops will prove very desirable, devoting the land to cabbages, onions, peppermint or some other suitable crop for two or more years until the land is free of these spores.

Insects Affecting the Celery Plant*

The celery plant is by no means immune to insect attack. It is preyed on by many of the garden pests, army worms, cut worms, the zebra caterpillar, the celery looper and by a number of other caterpillars. Besides these are several sucking insects, plant lice, leaf hoppers, a negro-bug and a thrips. Most conspicuous of all is the parsley caterpillar, which works also on carrots, caroway, fennel and other plants of the same family—a naked caterpillar nearly two inches long, green or yellow in color, with transverse black bands, and spotted with yellow. When disturbed, the larva protrudes a Y-shaped yellow horn, from which emanates a sickening odor, presumably distasteful to birds and other enemies. The adult is the common black, parsley swallow-tail butterfly, a beautiful velvet black butterfly having long swallow-tails, and marked by rows of yellow spots.

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* For details of spraying send to Michigan Experiment Station for bulletin on spraying.

Control of these insects will depend on their feeding habits. Grasshoppers should be killed by Criddle mixture, which is poisoned and slightly salted horse manure. Flea beetles may be driven away or killed by arsenate of lead, while the plants are small, that being the time when most injury is done. Cut worms like poisoned bran, made by mixing thoroughly, one pound of Paris green with fifty pounds of dry bran and then moistening it with a little molasses and water. The zebra caterpillar can be usually hand-picked profitably, as well as the parsley caterpillar. The plant lice and negro bugs should respond to a spraying with *strong* tobacco tea or with one of the nicotine extracts. This is true also of the thrips.

The leaf hoppers will be driven away by such a spray, but they will return after it evaporates. For the latter, a regular practice of clean culture, and the burning of all rubbish, after cold weather has set in, will gradually get rid of them, especially if this treatment be extended over a wide area. Many noxious insects winter in rubbish, fallen leaves, along hedges, etc.

R. H. Pettit,
Entomologist of Mich. Exp. Sta.

CELERY DISEASES

Bad Seed

There is scarcely a more vital question in celery growing than that of the quality of seed used. Seed that is of a bad strain though true to varietal name, may inflict losses of hundreds or thousands of dollars on large growers. Hollow celery, or that otherwise useless, according to present knowledge is very often due to the bad seed.

Black Root

Found on plants in seed beds.

Damping Off

This trouble is caused by a fungus which follows careless watering while the plants are very small, attacks the seedlings at the point where they emerge from the soil, causing them to decay at this point. This disease may be avoided by starting the plants in trays, and subwatering them by setting the trays in a shallow trough containing about 1 inch of water, allowing the water to enter through the drainage holes in the bottom of the tray. In this way the surface of the soil will remain slightly dry, while the roots of the plants receive plenty of moisture. Where it is impracticable to apply subwatering methods it will be necessary to water very carefully and to avoid extremes of drought and moisture. It is best to prevent too rapid evaporation by partial shading with lath screens.

Early Leaf Blight

Cercospora apii

Plants may develop this disease in the seed bed, and it is most prevalent in early summer.

Control

Keep young plants coated with 4-4-50 Bordeaux mixture, later using the non-staining ammoniacal copper carbonate solution. Well-drained, half-shaded fields seem to suffer less than others.

Heart Rot

Heart rot is a very destructive decay of the inner, or heart, portions of the celery plant after blanching has begun. The inner parts rot very suddenly, emit a penetrating odor and the market value of the affected celery is destroyed.

The decayed parts are teeming with motile bacteria to which this form of decay has been attributed. The heart rot prevails too in very hot, steamy weather, but preventive measures are about all that can be recommended. It is suggested that when the boards are first put up to the celery, under such conditions as accompany the heart rot, they should be left apart at the top and only closed up to the usual point after an interval of several days. This secures better ventilation and often prevents the disease.

A. D. SELBY,
Wooster, Ohio

HOLLOW CELERY. See *Bad Seed*, this section.

Late Blight

Septoria petroselini var. apii

F. D. BAILEY

The disease commonly known as late blight of celery seems to be the most serious disease of that crop in Oregon. It is commonly found in most parts of this country where celery is grown. It also occurs in Europe, and by many is believed to have been introduced into this country, probably through seed. There is a possibility, however, that a similar disease is present on some native weed of the celery family and has spread to the cultivated varieties of celery.

This disease occurs in the plants in the form of spots on the blade of the leaf, though the disease may attack the leaf bases. The spots are small, irregular in outline, and tawny in color (Fig. 1). These spots are caused by a fungus known as *Septoria petroselini*, var *apii*. If examined with a hand lens, numerous small black specks which are slightly raised may be seen scattered irregularly in the spots. These spots contain the reproductive bodies or spores of the fungus. These spores escape through a minute opening and, being scattered by wind and rain, cause the growth of new spots. The spots may appear on the first leaves of the seedlings in the seed bed, a fact which suggests the possibility that the disease may be carried through the seed.

When the fungus is abundant on the leaves, and especially on the leaf bases, there is a tendency to make the stalks brittle, so that minute transverse cracks are formed which reduce the market value.

Usually the spots are clearly defined, but under favorable conditions for the development of the fungus, the entire leaflet may be affected, resulting in a complete wilting of the leaves.

The disease may also develop seriously in storage, particularly if the storage houses are too warm or are poorly ventilated.

It is probable that the disease lives over winter in the dead leaves that are left in the fields at digging time.

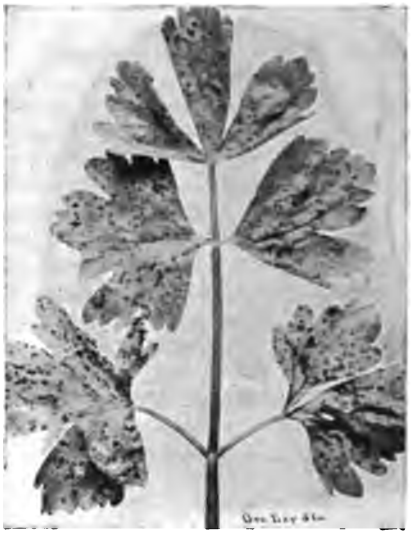

Fig. 1. Leaf Spot or Late Blight of Celery.

Remedy

It is advisable, so far as practical, not to trim the plants in the field. Diseased plants and leaves should not be thrown in the compost heap if the compost is to be used as fertilizer for celery beds or fields. It is also advisable, where possible, to practice a three or four year rotation of crops.

Spraying must be practiced as a preventive. The seedlings should be sprayed frequently (at least once a week), beginning when they show the first leaves. The plants should be sprayed in the field often enough to cover new foliage, and especially after every heavy rain. Bordeaux mixture should be used in the 4-4-50 formula. Ammoniacal copper carbonate may be used for the later sprays in the field, as this mixture does not leave a deposit on the plants.

The practice of overhead sprinkling, as followed by many growers, is especially undesirable as this has the same effect as frequent rains and offers ideal conditions for the development and spread of the fungus. Where irrigation is necessary, arrangements should be made to apply the water in rills.

Bibliography

1897—N. Y. Cornell Experiment Station Bulletin 132.

California Experiment Station Bulletin 208.

Root Rot

Rhizoctonia

Attacks plants during damp seasons. The roots rot off in some cases.

Rust, True and False

In Europe the celery plant is attacked by one or two rust fungi *(Puccinia bullata* [Pers.] and *P. Castagnei* Thum) of the same class of parasitic fungi as those producing rust in wheat. These two rusts have not as yet been discovered in America, though they will doubtless in time become introduced. Celery which is banked in the earth often has the blanched stems marked by rusty spots of various sizes. These spots appear to arise from the contact of the stems with the earth, and on microscopic examination seem to be due to the fungi or bacteria, or both, that may be present in the soil. The difficulty is prevented by avoiding this method of blanching and substituting boards or close culture planting.

A. D. SELBY,
Wooster, Ohio.

CELERY PESTS

APPLE LEAF HOPPER. See under *Apple Pests.*

CABBAGE ROOT MAGGOT. Sometimes attacks celery. See under *Cabbage Pests.*

Celery Leaf Tyer

Phlyctaenia rubigalis

This insect often becomes very troublesome, not only because it destroys the leaves by eating them, but by spinning a web and tying the leaves together. The insect is thoroughly distributed and may at any time become a troublesome pest in any celery field. As a means of controlling this insect, hand picking will be effectual on a small scale. Spray with Paris green in cases where the larvae have become very numerous. Applied so as to reach the underside of the leaves, where the insects feed. It would not be advisable to spray with a poisonous solution late in the season after the edible portion of the celery has begun to form.

Celery Looper

Plusia simplex Guen.

[*] In some portions of our country, as, for example, in Illinois, this species to a certain extent takes the place of the cabbage looper *(Plusia brassicae* Riley). It is stated to be the commonest species of its genus in Illinois, and is rather generally distributed in the United States east of the Rocky mountains, from Canada to New Mexico.

Descriptive

The moth is decidedly dissimilar to that of the cabbage looper, having a greater wing expanse, nearly two inches, entirely different coloration, and differently shaped upper wings. The lower edges of the fore wings have a well-defined conical projection. The border is not scalloped, the color is somewhat purplish brown, the darker shades being velvety brown. The silver marks are very distinct. The hind wings are ochreous or yellowish brown, strongly banded with dark fuscous, particularly toward the white border. The ground color of the thorax, fore wings, and abdomen is duller than that of the hind wings. The lower surface is pale ochreous, with a rather distinct darker band running through both wings near the middle.

The egg is milky white, flattened, globular, or turnip-shaped, sometimes with an impressed spot in the center of the upper surface. The upper half of the egg is grooved vertically.

The larva is similar to the cabbage looper. The color is very pale yellowish green. The length is about 1½ inches when fully extended.

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[*] Chittenden. Division Entomological Bulletin 33, New Series.

Remedy

Paris green applied to the under side of the leaves.

Celery or Parsley Caterpillar

Papilio polyxenes Fab.
Family *Papilionidae*
Papilio asterias Fab.

General Appearance

The most evident forms of this insect are the feeding caterpillars, which are indeed very striking. The youngest of these are noticeably darker with yellow spots. When full grown they are yellowish green with distinct black bands and dots on the bodies. If disturbed they throw out a forked, orange-colored scent organ behind the head, which exhales a very pungent and characteristic odor. The eggs are about 1 mm. in length, at first yellow and later reddish brown in color, and flattened at the attached end. The adult butterflies are commonly known as the black swallowtails, being black with yellow markings. The chrysalids vary from green to dull gray and are more or less mottled. The zebra caterpillar is equally striking in appearance but smaller.

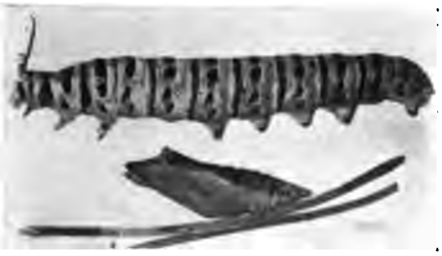

Fig. 1. Caterpillar and Chrysalis of the Parsley Butterfly (*Papilio polyxenes* Fab.) (Original.)

Life History

The eggs are laid upon the food plants from spring to early summer and hatch in about ten days. The caterpillars are voracious feeders and develop very rapidly, being ready to form chrysalids in about one month after hatching. Chrysalids hatch in about two weeks. The adults being strong fliers are able to scatter their broods over large areas. There are several generations a year.

Food Plants

In many localities this caterpillar is a serious pest of celery and parsley, but feeds also upon carrots, caraway, parsnips, dill, fennel and related wild plants.

Control

Though the caterpillars may be controlled by poison sprays on some crops, these are not safe for celery and parsley. The larvae are so conspicuous as to make hand picking one of the best methods of control. If care is exercised to collect and destroy the first larvae the second and more damaging brood will be greatly reduced. Concerted action on the part of all growers is necessary to bring satisfactory results.

Natural Enemies

The ichneumon parasites, *Trogus vulpinus* Grav. and *T. exidianator* Brulle, destroy great numbers of the chrysalids.

E. O. Essig

Grasshoppers

Some species of grasshoppers often prove destructive pests during the early part of the season, especially where the celery is planted near meadows or other habitat of these insects. Where no fowls are allowed to run, it is practicable to poison the grasshoppers by means of wheat bran to which there has been added molasses and water and enough Paris green to give the mixture a slightly green color.

Parsnip Louse. See under *Parsnip*.

Tarnished Plant Bug

This insect while not considered a dangerous celery insect, has been known to injure the crop in several instances. While young this bug is very small, being only about one-twentieth of an inch in length, of a yellowish or yellowish-green color, which changes to a faded yellow or dull brown when it is fully grown. It works especially where weeds abound and on crops that are somewhat neglected. As a preventive, keep the celery well cultivated and free from weeds, and do not allow any trash to lie over the ground beneath which the insects can pass the winter. Kerosene emulsion is moderately effective when thoroughly applied. The insects are sluggish during the early morning and many of them can be caught by means of a large butterfly net; but in all cases it will be as necessary to destroy insects found upon surrounding crops and weeds.

ZEBRA CATERPILLAR. See *Celery Caterpillar*, this section.

CELERIAC, CULTURE OF. See *Alaska*.

CHECKING GROWTH, COVER CROPS FOR. See *Apple Orchard, Cover Crops*.

CHEMICAL COMPOSITION OF APPLES. See *Fertilization of Apple Orchard*.

CHEMICALS REMOVED BY VARIOUS CROPS. See *Apple Orchard, Cover Crops*.

The Cherry

The origin of the cherry, like that of many of our domestic fruits, is lost in the unwritten history of the evolution of plant life. If we could see the cherry from which all varieties of cherries have come, and then if we could see that from which this original cherry sprung, and so on back step by step until we reached a point beyond which we cannot go, there would at least be educational interest in it, and having traced one species back to its original, we might, with strong presumption of truth, say that this is the path all other fruits have trodden. Being denied this privilege, we classify the cherry under its genus, *Prunus*, and the seedling cherry under its species, *Avium*.

There is no doubt that certain varieties were introduced into this country from the older countries, but when they came there were cherries growing wild in this country that came from some source, no one knows where, and in all probability travelled the same path as the cherries of Europe or of the Orient, which under cultivation were improved and brought to this country in the improved state.

The wild cherry grew in the Atlantic states and in the Middle states as late as 1865, or even later. The writer came to Illinois about that time and settled on the prairies near a point of timber that skirted the stream called Bruiletts Creek. A little village called Cherry Point had sprung up at the point of timber, extending out into the prairie. In that skirt of timber there were cherry trees large enough to be manufactured into lumber, and they were used for the various purposes of fencing, building, etc.

At the time it did not occur to us to measure the trees, for we did not think their size was of much consequence, except as they could be utilized for the time being, but as we remember them now, they must have been 18 inches to 3 feet in diameter. Then, in the little groves on the prairies were cherry trees of smaller size that nearly always bore fruit. The fruit of the large and the small varieties was not the same in size or color, one being black and the other reddish, but they were cherries and there was no greater difference between them, than exists now between the light and dark colored fruits of the same name, but of improved varieties. In the hill lands of Oregon, near the coast are large wild cherry trees, highly prized for lumber.

From *Prunus Avium* the following varieties have sprung:

First. The Mazzards, or inferior seedling fruit of various shapes and colors, the trees often attaining great size.

Second. The Hearts, or heart shaped sweet cherries, light or dark, represented by the black Tartarian and Governor Wood.

Third. The Bigarreaus, or heart shaped, firm fleshed, sweet cherry, like the Napolean and Windsor.

Fourth. The Dukes, light colored, somewhat acid in flesh, such as the May Duke and the Reine Hortense.

From *Prunus Cerasus*, the following varieties have sprung:

First. The Armarelles, or light colored, sour cherry with colorless juice, represented by the Early Richmond and Montmorency.

Second. The Morellos, or dark colored, sour cherry with dark colored juice like the English Morello and Louis Philippe.

The Mahaleb is a type brought from the Old World, and is hardier and smaller

Lamberts.

—Colville Photo.

than most other types, therefore is often used as a stock on which to bud, and on which to grow better varieties.

Soil Best Adapted

In its wild state, the cherry is generally found growing on a porous, sandy, moist soil. It will grow on a variety of soils, but it does best where the soil is not too wet, where there is not too much clay and where there is not a hardpan subsoil. For the best fruiting, there should not be too much humus in the soil, as this leads to a heavy wood growth; but it should be rich in mineral elements. The soil should always be well drained, and if the cherry orchard has not natural drainage, it should be tiled or drained with surface ditches; for the cherry tree will not do its best in a damp soggy soil. Further, during the early part of the year, when the tree is developing or ripening its fruit, there should be more water than in the latter part of the season, when it is passing into a dormant state.

Planting the Trees

As in the planting of other orchard crops, the soil should be well prepared, graded, pulverized and all roots, trash and other obstructions to subsequent cultivation, removed. This is especially important if the ground is to be irrigated; but is subject to some modifications in the humid climates, where irrigation is not practiced.

As to whether the square, hexagonal or some other method of planting is adopted, is a matter of choice, depending somewhat on conditions. See our article on planting under *Apple*.

The distances apart will depend on soil, climate, and the purposes of the grower; but most of all upon the varieties planted. For instance, the sour cherry, is not a large tree when it has reached maturity, and may be planted 20 to 25 feet apart, with reasonable assurance that the trees will not crowd each other when full grown. The sweet cherry will grow twice as large as the sour cherry,

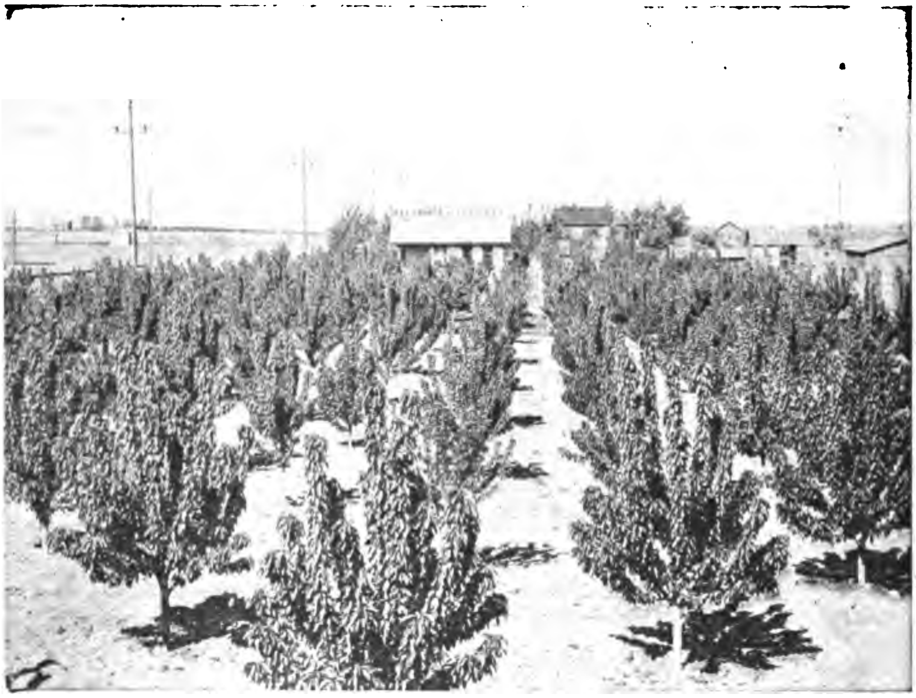

Fig. 1. A Well Arranged and Well Cared for Cherry Orchard, Three Years Old.
—*Courtesy N. P. Ry.*

and will require nearly twice the space. Where there is plenty of moisture, the trees may be planted at less distance, as where there is barely enough; because where the water is scarce, the roots have to draw moisture from a larger area than where it is abundantly supplied.

Where there is plenty of water, and a rich soil, the tendency will be toward a heavy wood growth at the expense of heavy fruitage; while in regions where the soil is thin and the water scarce, the tendency will be toward heavy fruitage at the expense of wood growth. Under these latter conditions, the tree would probably lack vital force and be short lived.

Cherries as Fillers

It is common in some sections to plant an apple orchard, selecting other fruits as fillers to be planted between the rows of apples and to be cut out when the trees begin to crowd and the apples need the space. For this purpose, peaches, pears, and other fruits have been selected. The cherry is not adapted to this form of planting since it requires a different method of cultivation from any of the fruits named. It matures its crop early and requires the remainder of the season for the development of its fruit spurs for the coming year; also requires less water during this period, and less humus than the other crops.

The rules for the planting of the cherry, are but little different from those of any orchard fruits. It is important to have the holes large enough to receive the roots without crowding, and deep enough so that the tree is set a little deeper than when in the nursery. Tramp the soil well about the surface, to hold the tree from shaking in the wind.

The age of the tree at the time of planting is a subject of controversy and opinions differ, generally, with differing conditions. In the Northeastern states, and in Canada, the preference seems to be generally in favor of two-year-old trees. In the Western states, especially the Pacific coast states, the preference is in favor of one-year-old trees. This difference grows partly out of the fact that in the West, where the climate is milder, the seasons longer, and the lands are irrigated, the trees make a much more rapid growth than in the Northeast, and are approximately as large in one year as in the East in two years. Even where irrigation is not the rule in the Pacific coast regions, as in the Willamette valley in Oregon, or west of the Cascades in Washington, the climate is mild, the rainfall abundant and most abundant at the time the cherry most needs it; therefore, this region is peculiarly adapted to the growing of cherries. Under these conditions, we think the choice of one-year-old stock is decidedly preferable, to two-year-old stock. Further, the earlier in the life of the tree the head is shaped, the less it is damaged by cutting, and the better top it will form.

Cultivating a Cherry Orchard

For the first three or four years at least the cherry orchard should have clean culture. This does not mean that vegetables which require cultivation may not be grown among the trees. In fact, we think this is ordinarily an advantage rather than a disadvantage, because it does not injure the trees, insures cultivation, and utilizes much land that is otherwise wasted. It does mean that the growing of grass, especially blue grass, or timothy, is not favorable for the best growth of the trees. Much depends on the nature of the soil. West of the Cascades where the soil is rich in humus and where the tendency would likely be toward a heavy wood growth, a fall crop of oats, fall wheat or winter rye, might be grown. On the east side of the Cascades, where the soil is rich in mineral substances, but lacks nitrogen and humus, a cover crop of clover, peas, alfalfa, or vetch, might be grown. There are no rules that apply equally well under all conditions, and the orchardist must always decide for himself what are the soil and climatic conditions, and how they should be utilized in reference to the crop he is growing. The cherry, like all other trees, must be adapted to its environment in order to produce the best results. There is perhaps no part of the

United States where the natural conditions are more favorable for the growth of the best varieties of cherries, than the Pacific coast region, west of the Cascade mountains.

From the Oregon Experiment Station we learn that as high as 500 to 800 pounds of cherries have been grown from a single tree, and that from $100 to $200 per acre net profit is not unusual; but that the money realized often runs as high as $600 to $700 per acre. I think that for Washington, these figures might be easily duplicated, although in exceptional cases, I have seen larger yields.

GRANVILLE LOWTHER

Cost of Harvesting Cherries

The following statement was reported from Ohio to Green's Fruit Grower (Feb., 1912).

No. crates per acre	530
Average price per crate	$2.00
	$1,060.00
Picking, per crate	$0.48
Crate (new)	.25
Express	.20
Commission	.20
Total	$1.13
Total cost of harvesting	$598.90
Net returns per acre	461.10

This covers harvesting costs only and the crop was an unusually large one.

Propagation of Cherries

W. L. HOWARD

The cherry is propagated almost entirely by budding. While seedlings from our common varieties may be used for growing stock, nurserymen always use special kinds of stock which are usually imported from France. The kinds of stock in most general use are the Mazzard and Mahaleb. The Mazzard is the best stock for both sweet and sour cherries in the East. The Mahaleb is more widely used for the sour kinds, however, for it is easier to bud, and is free from leaf blight in the nursery. The Mazzard, however, appears to form a better root system, stronger union, makes a longer lived tree and is sufficiently hardy. For the plains states the hardier Mahaleb stock should be used. Both of these may be secured from most any nurseryman in early winter or spring. In a small way, it is quite feasible to grow one's own cherry stock from the seeds of the fruit raised at home.

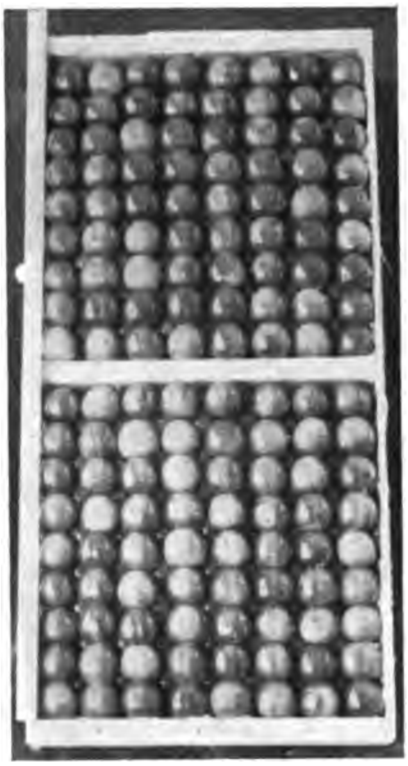

Fig. 2. Royal Anns Properly Packed. For Rules for Packing Cherries see Packing under Apple.

Cherry seeds should not be permitted to become thoroughly dried out at any time. On this account it is advisable to store the seeds through the remainder of the summer, after ripening, in boxes of sand and bury them from eight to twelve inches deep in the ground in a cool place. This will keep them moist, and at the same time they will be sufficiently cool and away from the free circulation of air that they will not begin to grow.

At the approach of cold weather the seeds should be taken up and the open boxes of sand kept on the surface of the ground in the shade of a building throughout the winter. Very early in the spring the seeds should be planted in nursery rows four feet apart and an inch or two apart in the rows. Cover with an inch or two of fine soil, if the ground is not too wet. If the seeds are about to sprout and the soil is yet too wet to work well, the seeds should be partially covered with the wet earth and then a dressing an inch thick of well-rotted manure spread over the rows.

The young seedlings should have thorough cultivation during the summer. About the last week in August or the first week in September, or earlier, if the bark peels readily, the budding should be done. In the South where the spring opens much earlier, the seedlings may be large enough for budding in June. In that event, one year's time is saved, as the tops are cut off immediately, and the young trees often grow to transplanting size the same season. Full details for the budding is given under the discussion of peaches. When the trees have had one year's growth from the buds, they are of the proper age to be transplanted to the orchard. Cherry seedlings are sometimes cleft-grafted in spring, where the buds the previous fall failed to take.

Pruning the Cherry

The cherry has the annoying habit of occasionally producing strong shoots from adventitious buds along the trunk of the tree or from near the surface of the ground. A close watch should be kept for such interlopers in order that they may be promptly removed.

Framework

During the early years of the growth of the cherry care should be exercised to secure a proper distribution of the limbs which are to form the framework branches of the tree, particularly with the sweet cherries, as this species has the unfortunate habit of dividing into two shoots of nearly equal size with a close angle between, which always forms a weak joint. Trees not carefully pruned to overcome this bad habit are liable to severe injury from splitting when heavily loaded with fruit.

Cutting Back

In the early period of the growth of the sweet cherry, the annual growth will need more or less severe cutting back, depending upon soil and climatic conditions, in order to maintain them within bounds. On general principles this heading should be done just before growth starts in the spring.

Fruiting Habits

The fruiting habits of the cherry are more closely allied to those of the apple and the pear than to the peach, and for that reason the shortening of the annual growth is of less moment than with the peach.

Pruning First Four Years

W. S. Thornber

During the first four years of a young cherry tree's life in the orchard it should be carefully, systematically and regularly pruned. By this time it should be large enough and its frame work so well developed that the future pruning would consist largely of the removal of dead, diseased, broken or crossed limbs and an occasional heading back or thinning out of the fruiting wood. Pruning for the production of wood after a tree starts to bear should not be necessary as there is a relationship existing between the amount of wood produced and the size of the crop borne, in the case of most varieties of cherries.

How to Prune

The first and most essential pruning of a cherry tree should take place just previous to the beginning of its second year's growth. When one-year-old trees are planted in the orchard, immediately after transplanting, is a good time to give it this pruning. All lateral branches should be cut off close and the top headed back to from 24 to 36 inches from the ground. The purpose of this pruning is to establish a low headed spreading tree rather than a high upright tree. The young tree will require no further pruning until the beginning of the third year's growth unless a very strong sprout springs from the root or on the main stem six inches or less from the ground, necessitating immediate removal.

At the beginning of the third year's growth from three to five of the best branches should be selected to form the frame work of the tree. The remainder should be cut off and those headed back to from one-third to one-half of their original length, cutting to outer buds always and maintaining the most central one as a leader, which should be from four to six inches longer than the rest. These branches should be selected with special reference to their position on the main stem and to one another. They should have wide angles, no two should be opposite and be as far apart as possible on the main stem.

The pruning for the fourth and fifth year's growth should be very much the same as for the third, using special care to thin the tops and cut back in such a manner as to spread the top as much as possible. After this only the necessary pruning should be done, as heavy pruning tends to produce wood growth which is not at all desirable in bearing trees.

When to Prune

The pruning of young growing trees should be done late in the winter or early in the spring, but never early in the winter.

CHERRIES IN ALASKA. See *Alaska*.

Cherries—Trees, Production and Value
U. S. Census 1910

	——1910——		——1909——		1899
Division or State—	Trees of bearing age	Trees not of bearing age	Production (bushels)	Value	Production (bushels)
United States	11,822,044	5,621,660	4,126,099	$7,231,160	2,873,499
Geographic Divisions:					
New England	68,236	82,587	14,904	38,424	28,445
Middle Atlantic	1,851,144	659,953	791,326	1,541,708	775,587
East North Central.....	3,853,974	1,528,247	1,410,298	2,862,344	851,326
West North Central.....	2,768,659	1,117,538	515,690	935,537	297,878
South Atlantic.........	1,063,825	364,118	327,706	394,990	391,799
East South Central.....	453,262	257,112	94,873	143,166	49,457
West South Central.....	385,502	242,569	9,954	14,401	13,635
Mountain	390,644	581,641	147,854	300,485	33,956
Pacific	986,798	842,900	813,494	1,500,105	436,421
New England:					
Maine	14,288	6,653	2,408	7,164	1,550
New Hampshire........	9,463	6,326	1,408	4,133	1,183
Vermont	18,006	6,659	2,506	7,651	1,069
Massachusetts	13,396	6,776	4,761	10,848	6,043
Rhode Island	964	453	214	464	1,329
Connecticut	12,119	5,720	3,617	8,164	12,271
Middle Atlantic:					
New York	673,989	342,959	271,597	544,508	218,642
New Jersey	102,124	36,743	44,636	87,225	82,005
Pennsylvania	1,075,031	280,251	475,093	909,975	474,940
East North Central:					
Ohio	1,144,271	342,328	338,644	657,406	192,954
Indiana	815,742	251,959	363,993	508.516	228,485
Illinois	843,283	239,605	287.376	453,474	204,279
Michigan	760,183	540,580	338,945	590,829	194,541
Wisconsin	290,495	148,775	81,340	152,119	31,067
West North Central:					
Minnesota	25,139	38,399	1,526	2.973	960
Iowa	908,764	229,352	260,432	455,022	118,743
Missouri	622,332	247,425	123,314	222,510	62,708
North Dakota	5,076	21,484	209	445	4
South Dakota	51,613	76,293	5,924	12,981	900
Nebraska	494,468	267,529	89,876	164,872	54,047
Kansas	661,267	237,051	34,409	76,734	60,511
South Atlantic:					
Delaware	16,145	4,598	2,634	4,850	8,066
Maryland	82,305	27,774	42,315	60,121	60,452
District of Columbia....	435	4	235	568	248
Virginia	352,783	83,323	132,671	134.428	188,693
West Virginia	332,429	124,567	79,723	111,043	87,828
North Carolina	168,065	74,111	53,788	60,453	33,899
South Carolina	60,274	25,764	10,987	15,880	6.551
Georgia	50,723	23,479	4,979	7.199	5,950
Florida	666	498	374	448	112
East South Central:					
Kentucky	212,118	102,766	52,163	74.340	34,258
Tennessee	201,830	128,406	36,303	60.294	11,688
Alabama	25,566	16.673	3,588	4.783	1,159
Mississippi	13.748	9,267	2,819	3,749	2,352

Cherries—Trees, Production and Value—Continued
U. S. Census 1910

Division or State—	1910 Trees of bearing age	1910 Trees not of bearing age	1909 Production (bushels)	1909 Value	1899 Production (bushels)
West South Central:					
Arkansas	60,046	47,556	5,993	8,424	7,889
Louisiana	975	760	527	921	336
Oklahoma	295,042	150,541	2,372	4,393	*3,221
Texas	29,439	43,712	1,062	663	2,189
Mountain:					
Montana	19,938	24,237	7,497	17,985	807
Idaho	61,381	95,423	22,609	41,766	12,294
Wyoming	919	4,025	68	251	1
Colorado	203,806	319,624	88,937	173,895	5,387
New Mexico	21,925	26,818	6,384	10,684	5,228
Arizona	812	1,608	476	840	220
Utah	70,775	109,119	21,402	54,170	9,905
Nevada	1,588	787	481	894	114
Pacific:					
Washington	241,038	229,067	181,392	278,547	52,114
Oregon	223,456	313,770	181,089	269,934	65,347
California	522,304	300,063	501,013	951,624	318,960

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* Includes Indian Territory.

Varieties of cherries recommended for cultivation in the various districts of the United States. See map on page 192.

District No. 1

HIGHLY RECOMMENDED — *Dessert and market*: Tartarian, *Black*. *Kitchen*: Bessarabian; Brusseler Braune; Lutovka.

RECOMMENDED — *Dessert, kitchen and market*: Ostheim. *Kitchen and market*: Large Montmorency; Montmorency Ordinaire; Morello, *English (Wragg)*; Richmond, *Early*. *Dessert and kitchen*: May Duke. *Market*: Amarelle Hative; Shadow Amarelle. *Kitchen*: Dyehouse; Philippe, *Louis*.

District No. 2

HIGHLY RECOMMENDED — *Kitchen and market*: Large Montmorency; Montmorency Ordinaire; Morello, *English (Wragg)*; Richmond, *Early*. *Dessert and market*: Black Heart; Eagle, *Black*; Elkhorn; Elton; Hortense, *Reine*; Rockport; Tartarian, *Black*; Windsor; Wood, *Governor*. *Dessert and kitchen*: May Duke; Olivet. *Market*: Napoleon *(Royal Ann)*. *Dessert*: Eugenie, *Empress*; Spanish, *Yellow*. *Kitchen*: Bessarabian; Dyehouse; Late Duke; Late Kentish.

RECOMMENDED — *Dessert, kitchen and market*: Ostheim. *Dessert and market*: Downer; Lewelling. *Dessert and kitchen*: Archduke. *Dessert*: Choisy, *Belle de*; Coe *Transparent*; Early Purple *Guigne*; Knight *Early*; Mezel. *Kitchen*: Carnation; Lutovka; Magnifique, *Belle*; Philippe, *Louis*; Royal Duke.

District No. 3

HIGHLY RECOMMENDED — *Kitchen and market*: Large Montmorency; Montmorency Ordinaire; Richmond, *Early*. *Dessert and market*: Black Heart; Tartarian, *Black*. *Dessert and kitchen*: May Duke; Olivet. *Market*: Napoleon *(Royal Ann)*. *Dessert*: Coe *Transparent*; Spanish, *Yellow*. *Kitchen*: Late Kentish.

RECOMMENDED—*Kitchen and market*: Morello, *English (Wragg)*. *Dessert and market*: Downer; Eagle, *Black*; Elton; Hortense, *Reine*; Rockport; Windsor; Wood, *Governor*. *Dessert*: Choisy, *Belle de*; Mezel. *Kitchen*: Late Duke; Magnifique, *Belle*; Philippe, *Loui*; Royal Duke.

District No. 4

HIGHLY RECOMMENDED — *Kitchen and market*: Large Montmorency; Montmorency Ordinaire; Morello, *English (Wragg)*; Richmond, *Early*. *Dessert and market*: Black Heart; Hortense, *Reine*; *Windsor*. *Dessert and kitchen*: May Duke. *Market*: Napoleon *(Royal Ann)*. *Kitchen*: Dyehouse; Late Duke.

RECOMMENDED — *Dessert, kitchen and market*: Ostheim. *Dessert and market*: Downer; Eagle, *Black*; Elton; Tartarian, *Black*; Wood, *Governor*. *Dessert and kitchen*: Olivet. *Dessert*: Choisy, *Belle de*; Coe *Transparent*; Early Purple

Guigne; Eugenie, *Empress;* Spanish, *Yellow.*

Recommended for trial—*Dessert, kitchen and market*: Suda *Hardy.*

District No. 5

Recommended — *Kitchen and market*: Large Montmorency; Morello, *English (Wragg);* Richmond, *Early. Dessert and market*: Eagle, *Black;* Elton; Rockport; Tartarian, *Black;* Windsor; Wood, *Governor. Dessert and kitchen*: May Duke. *Market*: Napoleon (*Royal Ann*). *Dessert*: Coe *Transparent;* Choisy, *Belle de;* Early Purple *Guigne;* Knight *Early;* Mezel; Spanish, *Yellow. Kitchen:* Dyehouse; Late Duke; Magnifique, *Belle.*

District No. 7

Recommended—*Kitchen and market*: Montmorency Ordinaire. *Dessert and market*: Black Heart. *Kitchen*: Magnifique, *Belle;* Plumstone *Morello.*

District No. 8

Highly recommended — *Kitchen and Market*: Large Montmorency; Montmorency Ordinaire; Richmond, *Early;* Morello, *English (Wragg). Kitchen:* Late Kentish.

Recommended—*Dessert, Kitchen, and market*: Ostheim. *Dessert and market*: Eagle, *Black;* Tartarian, *Black;* Wood, *Governor. Dessert and kitchen*: Olivet. *Market*: Napoleon (*Royal Ann*). *Dessert*: Spanish, *Yellow. Kitchen*: Carnation; Dyehouse; Lutovka; Philippe, *Louis;* Plumstone *Morello.*

Recommended for trial — *Dessert, kitchen, and market*: Suda *Hardy. Kitchen:* Bessarabian; Brusseler Braune; Northwest.

District No. 9

Highly recommended — *Kitchen and market*: Large Montmorency.

Recommended—*Dessert, Kitchen, and market*: Ostheim; Morello, *English* (*Wragg*). *Market*: Amarelle Hative. *Kitchen*: Bessarabian; Brusseler Braune; Lutovka.

Recommended for trial — *Market*: Shadow Amarelle. *Kitchen*: Dyehouse.

District No. 10

Highly recommended — *Dessert and kitchen*: Olivet.

Recommended — *Kitchen and market*: Large Montmorency; Morello, *English* (*Wragg*); Richmond, *Early. Dessert and market*: Wood, *Governor. Dessert and kitchen*: Archduke; May Duke. *Market*: Napoleon (*Royal Ann*). *Kitchen*: *Dyehouse*; Late Duke; Lutovka.

District No. 12

Highly recommended — *Kitchen and market*: Large Montmorency; Montmorency Ordinaire; Richmond, *Early;* Morello, *English* (*Wragg*). *Dessert and Market*: Hortense, *Reine;* Republican, *Black;* Windsor. *Dessert and kitchen*: May Duke. *Market*: Napoleon (*Royal Ann*). *Dessert*: Choisy, *Belle de;* Eugenie, *Empress;* Knight *Early. Kitchen*: Late Duke; Royal Duke.

Recommended — *Dessert and market*: Black Heart; Eagle, *Black;* Tartarian, *Black;* Wood, *Governor. Dessert and kitchen*: Archduke; Olivet. *Dessert*: Coe *Transparent;* Spanish, *Yellow. Kitchen*: Dyehouse; Philippe, *Louis;* Plumstone *Morello.*

District No. 13

Highly recommended — *Kitchen and market*: Morello, English (*Wragg*).

District No. 14

Highly recommended — *Kitchen and market*: Morello, *English* (*Wragg*). *Dessert and market*: Lewelling; Tartarian, *Black;* Windsor. *Dessert and kitchen*: May Duke. *Market*: Napoleon (*Royal Ann*). *Kitchen*: Late Duke.

Recommended—*Dessert, Kitchen, and market*: Ostheim. *Kitchen and market*: Late Montmorency. *Dessert and market*: Elton; Republican, *Black;* Wood, *Governor. Dessert*: Spanish, *Yellow. Kitchen*: Late Kentish; Philippe, *Louis.*

Recommended for trial—*Dessert and kitchen*: Olivet. *Kitchen*: Dyehouse.

District No. 15

Highly recommended — *Kitchen and market*: Richmond, *Early. Dessert and market*: Bing; Hoskins; Lambert; Lewelling. *Market*: Napoleon (*Royal Ann*). *Kitchen*: Late Kentish.

Recommended — *Kitchen and market*: Morello, *English* (*Wragg*). *Dessert and* *market*: Oxheart; Tartarian, *Black;* Wood, *Governor. Dessert and kitchen*: May Duke. *Dessert*: Early Purple *Guigne;* Spanish, *Yellow. Kitchen*: Late Duke.

District No. 16

HIGHLY RECOMMENDED—*Dessert and market*: Bing; Tartarian, *Black. Market*: Napoleon (*Royal Ann*).

RECOMMENDED — *Kitchen and market*: Richmond, *Early. Dessert and market*: Lewelling; Rockport.

District No. 17

HIGHLY RECOMMENDED—*Dessert and market*: Tartarian, *Black. Market*: Napoleon (*Royal Ann*).

RECOMMENDED — *Dessert and market*: Centennial.

RECOMMENDED FOR TRIAL—*Dessert and market*: Lewelling.

District No. 18

RECOMMENDED — *Kitchen and market*: Morello, *English* (*Wragg*). *Dessert and market*: Tartarian, *Black;* Centennial. *Market: Napoleon (Royal Ann).*

CHERRY DISEASES

Black Knot

Plowrightia morbosa Schw.

This is a conspicuous disease attacking the branches of cherry and plum trees but is more frequent upon the cherry varieties of the Morello type. It is due to a parasitic fungus. Insects, however, make harbors of the interior of the knots. The spores of the black knot fungus are ripened during the winter and scattered in early spring, finding lodgment on the new branches or in fractures on old ones, where their growth causes the formation of a new knot. Black knot may be prevented by spraying with Bordeaux mixture, but is more profitably controlled by carefully cutting off affected parts and burning them, making a clean sweep at least once each year and that *previous to March 1st*. This is a practicable measure and we have confidence in its efficiency.

(The disease occurs on wild cherries in the Northwest.—Ed.)

A. D. SELBY,
Wooster, Ohio.

Brown Rot

Sclerotinia fructigena

H. S. JACKSON

The rot caused by *Sclerotinia fructigena* on many stone fruits, is sometimes serious also on cherries. Moist weather conditions near the ripening time are favorable for the rapid development and spread of the disease. The fruit is more susceptible as it becomes mature. The disease makes its appearance on the cherry as a small brown spot, which gradually enlarges until the whole fruit is affected.

A general discussion of this disease together with recommendations for its control, will be found under Peach diseases.

Black Cherry Twig Blight

Sclerotinia seaveri Rehm

Has been found on wild cherry in New York.

Cherry Gummosis

H. P. BARSS

The term "gummosis" by itself denotes simply the abnormal development of gummy or mucilaginous substances, resulting in the formation of gum pockets or exudations from various parts of the plant. The tendency to gum formation is characteristic of plums, apricots, peaches, cherries and other stone fruits wherever grown, usually as a response to injury, disease or unsuitable conditions of soil, climate, etc. Citrus and other trees are often subject to similar gumming. We are concerned here, however, with this phenomenon as it appears on the cherry, especially on the sweet varieties in the Northwest.

Of the two groups of cherries, the sour cherries or *Prunus cerasus group*, and the sweet cherries or *Prunus avium* group, we find that the former are not nearly so susceptible to gum flow, while the latter seem particularly subject to serious attacks whenever they are cultivated, if we can judge by the reports that come from such widely separated points as Australia, Europe and the Pacific coast.

In the state of Oregon serious attacks of gumming in the cherry orchards were noticed at least as early as 1853, very early in the history of fruit raising in the Northwest.

It is not known to what extent the cherry industry in other parts of the United States suffers from the presence of gummosis. Little is heard from it in the drier, eastern portion of the Northwest; but in the moist valleys of Washington and Oregon, west of the Cascades, at least, the trouble now reaches such proportions as to dishearten many cherry growers and discourage other orchardists from planting cherries. The conditions demand a thorough investigation as to the causes, means of prevention and possible remedies.

Various Causes of Cherry Gummosis

As has been intimated, the formation and exudation of gum is to be considered as the result of an injured, diseased or otherwise abnormal condition of the tree. It is a symptom only and not the disease itself. The published literature on cherry gummosis brings to light many explanations for the appearance of this phenomenon, some well proved and others more or less theoretical.

Injuries

Mechanical injuries, such as bruises, may induce the formation of gum, but the wound usually heals quickly and the gumming ceases. The injection of certain chemicals into cherry trees has repeatedly caused gum flow, and such insects as borers may produce it; but these causes need not engage our attention.

Unfavorable Soil and Climatic Conditions

A disturbed or disordered physiological condition of the tree, produced by unsuitable soil, moisture, climate or other relations not perfectly understood, is undoubtedly an important factor and possibly even a primary cause in many cases of gummosis. It is often noticeable that trees set in low places, where excessive moisture is likely to be present, are more apt to be subject to the disease than those on better drained ground. But this cannot explain all, since some trees under the best of soil and moisture conditions are severely attacked. Gumming seems to be worse where soils or subsoils are poor or unfit. But may not a weakened condition of the trees due to such causes render them less resistant to definite diseases? Many good authorities in this country and Europe attribute to late frosts following warm spells many attacks of this trouble. Some methods of pruning and cultivation have also been held responsible for a certain amount of gummosis. While all these factors have, no doubt, some influence on gum-production, yet investigation reveals so many cases inconsistent with these explanations that we must look for other possible causes.

The Attacks of Fungi

Since the outbreak of a serious cherry disease in Germany in 1899 various bark-destroying fungi have been found associated with the disease. From observations up to the present it does not seem very probable that any of these are responsible for more than a small amount of injury to living trees in the Northwest. It is possible, however, that they play a more important role than has been suspected.

There also appear frequently on the trunks and limbs of dead or diseased cherry trees certain fungi of the wood-rotting types. Being found not infrequently on trees that are not totally dead, they have been suspected by some of having a hand in extending the diseased condition. It is not known, however, that these fungi have anything directly to do with the disease in question.

Description of the Disease

Numerous distinctly different troubles of the cherry may be accompanied by gum-production, hence, the term "cherry gummosis" should not be applied to any specific disease. It is my present opinion, however, that the greater part of the cherry trouble in the Northwest is due to a single disease appearing in a variety of forms between which there are hardly distinguishable gradations.

The More Serious Phases of the Disease

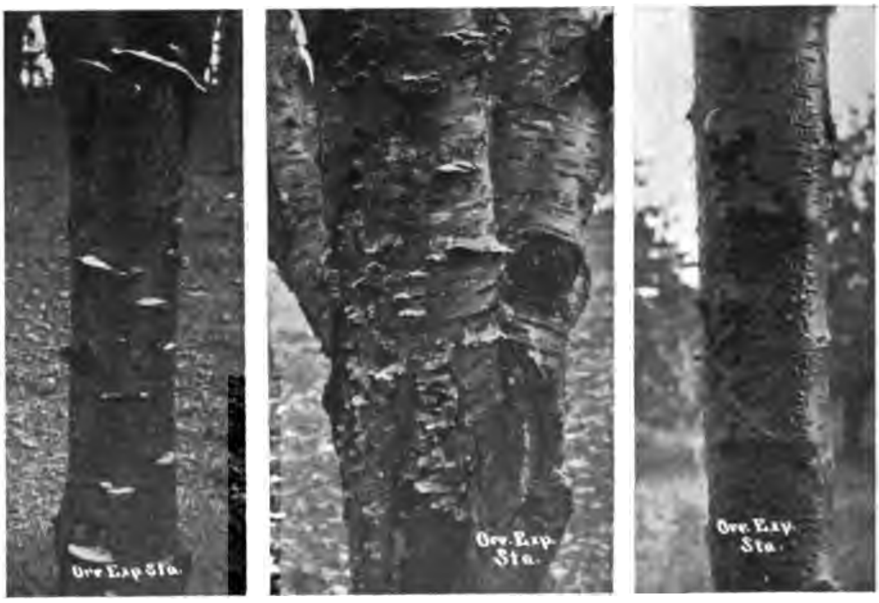
The condition most dreaded is where trunk and limbs are quite generally attacked. This may appear at its worst during the third and fourth year after setting out. Little indication of the disease may be present until tree or branches fail to leaf out or suddenly wilt during the growing season. In these cases girdling has previously taken place. There may or may not be gumming and little relation appears between the amount of gumming and the extent of injury. In the later stages there is usually no difficulty in detecting the disease on account of the fact that no further growth takes place at the affected region, while the adjacent and still healthy parts add a new layer of wood during the growing season. The dead area then appears flattened, and, the dead bark, since it does not expand, frequently, though not always, splits open. In other words, we have the formation of a canker.

More Restricted and Localized Cankers

In this disease we find certain conditions in which a large part of the tree may be rapidly and often fatally involved in a general attack, or in which large dead areas are formed that may girdle trunk or limbs, but the disease does not always appear in such severe forms, and we commonly find small cankers and affected spots that are more restricted and localized appearing on various parts of the tree. Near the center of such spots one frequently discovers the remains of a dead bud or spur. This association of small cankers with dead buds is not universal, but it is so common that it suggests the possibility that the diseased spot had its beginning in the death of the bud or spur. In connection with the dying of the tissue there is sometimes an abundance of gum production and sometimes very little where only a very small amount of tissue is found to be affected. Again, a canker may entirely girdle a branch with very little exudation occurring or none at all.

The Blighting of Buds and Spurs

There is a very common phase of our cherry trouble which has generally escaped the notice of the growers or has been passed by as unworthy of much attention. This is the blighting of buds and fruit spurs, generally accompanied by gumming, which is present in practically all cherry orchards to a greater or less extent, but is much worse in orchards



A Species of Polyphorus. A Species of Polystictus An Imperfect Fungus.
Fig. 1. Saprophytic Fungi Which Are Often Present in Half Dead Cherry Trees.

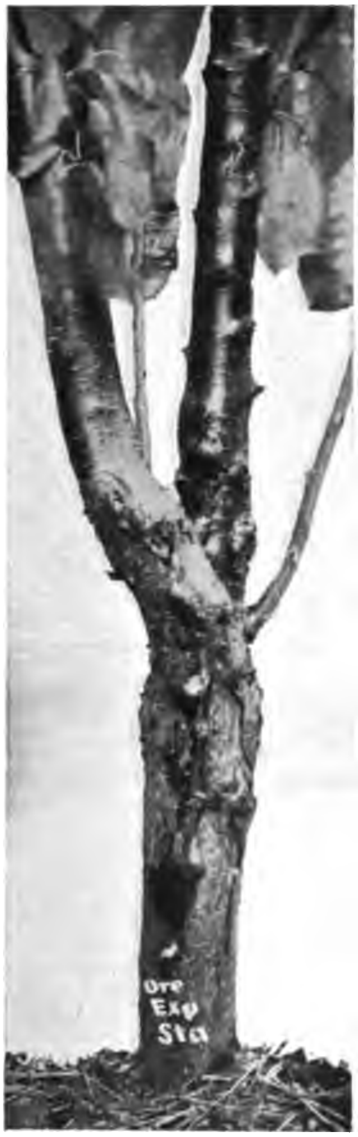


Fig. 2. Tree Showing the Serious Effects of the Disease on the Trunk, Crotch and Limb Bases, a Dangerous Condition. This is avoided by limb-grafting upon mazzard seedlings.

where trunks and limbs are badly diseased. Old trees and younger trees seem to be equally affected. This trouble is first noticeable early in the spring when some of the buds, which formed normally in the fall, fail to swell and open when the others unfold. (See Fig. 3.) A drop of gum often appears exuding from the bud or from the affected spurs. (See Fig. 4.) Sometimes affected buds unfold, but before the blossoms open, wilt down and dry up. Often, however, spurs come into full leaf and set fruit, only to die a week or two later. As far as our observation goes, blighting of this sort does not usually take place during the summer or fall.

The amount of damage directly produced by this form of disease is not very serious in most cases, but the after effects are probably much more important than has been supposed. Investigation shows that after a spur or bud has been blighted, a small area of discoloration usually spreads out from its base onto the branch. This is almost always confined at first to the outer layers of the bark. As in the case of larger cankers, a layer of wound cork eventually separates the diseased tissue from the healthy substance of the branch. The following season, however, the diseased area may spread farther

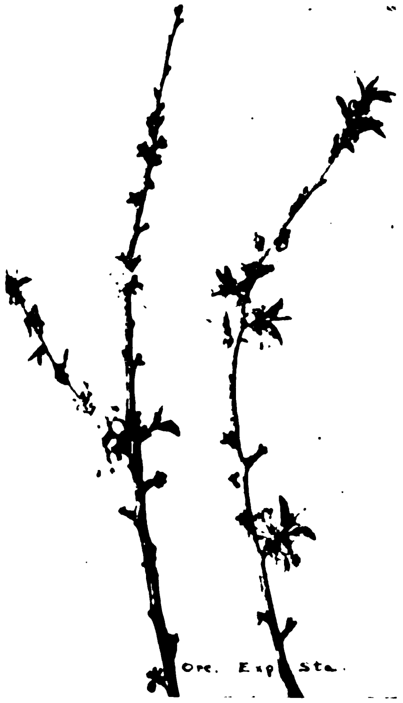


Fig. 3. Cherry Branches Showing Blighted Spurs Failing to Develop at Blossoming Time.

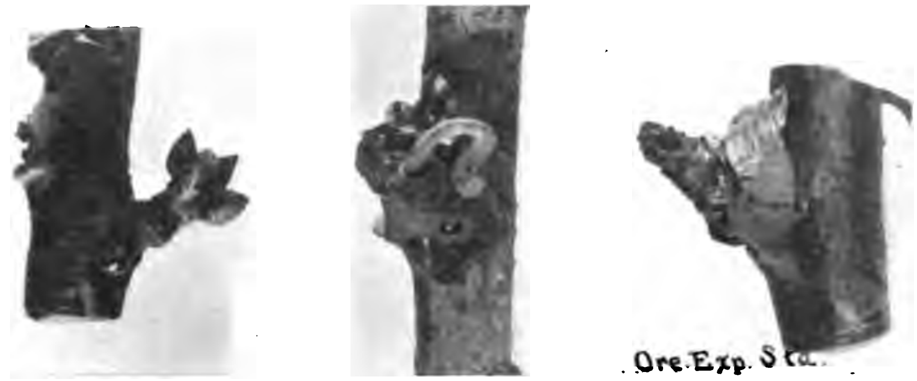


Fig. 4. Examples of Spur Blight Due to Bacteria. Drops and masses of gum ooze out from the dead spurs.

from the base of the spur, up and down the branch and also, more slowly, around it. The inner parts of the bark and the cambium become affected and a typical canker of small size results. Very often girdling follows and the whole end of a branch may be killed by a canker at its base. Practically all of the dead shoots which so often appear in the top of a tree during the year, seem to be caused by cankers spreading out from spurs or buds that died in some previous season or at the beginning of the same season.

Pseudomonas cerasus, Griffin, the Cause of Spur Blight

In March, 1909, Mr. F. L. Griffin found bacteria associated with blight of cherry buds. Inoculations with cultures produced the characteristic blight. Repeated tests were made during the next two seasons with buds from various districts, with the same results. Careful morphological and physiological studies led him to believe that a new species had been discovered and he accordingly described it under the name *Pseudomonas cerasus*.

This organism, then, seems to be the cause of one form of cherry gummosis. How much it has to do with other phases of the disease only further investigation can show.*

Recent Experiments and Observations

In February, 1912, the writer began his investigation of cherry gummosis and since that time has confirmed many of Mr. Griffin's previous observations and conclusions. Furthermore, the repeated discovery of bacteria similar to ***Ps. cerasus*** in the diseased areas on trunks, limbs or twigs, and the production of gumming by subsequent inoculation with these organisms, gives strong support to the idea that bacteria cause the characteristic injuries found on the bodies of trees affected with this disease.

Summary of Experiments and Observations

To sum up the result briefly: 1. The experiments of Mr. Griffin and the writer seem to indicate that a species of bacterium (*Ps. cerasus*) is responsible for the blighting and gumming of buds and spurs on common varieties of the sweet cherry. 2. This bacterium is also able to induce gumming when inoculated into the body and branches of these varieties. 3. Bacteria similar to ***Ps. cerasus*** have been found during the spring in nearly all spreading cankers on the trunks and limbs as well as in diseased spurs, and these, by inoculation into healthy trees, are able to induce gumming. 4. From observations made through one season only, it appears that the disease progresses rapidly in the spring and only slowly or not at all during the summer and autumn. 5. It is impossible to state positively from our present knowledge that bacteria are responsible for all the more serious phases of the disease on

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* See Science, N. S. 34, No. 879, p. 615, November 3, 1911.

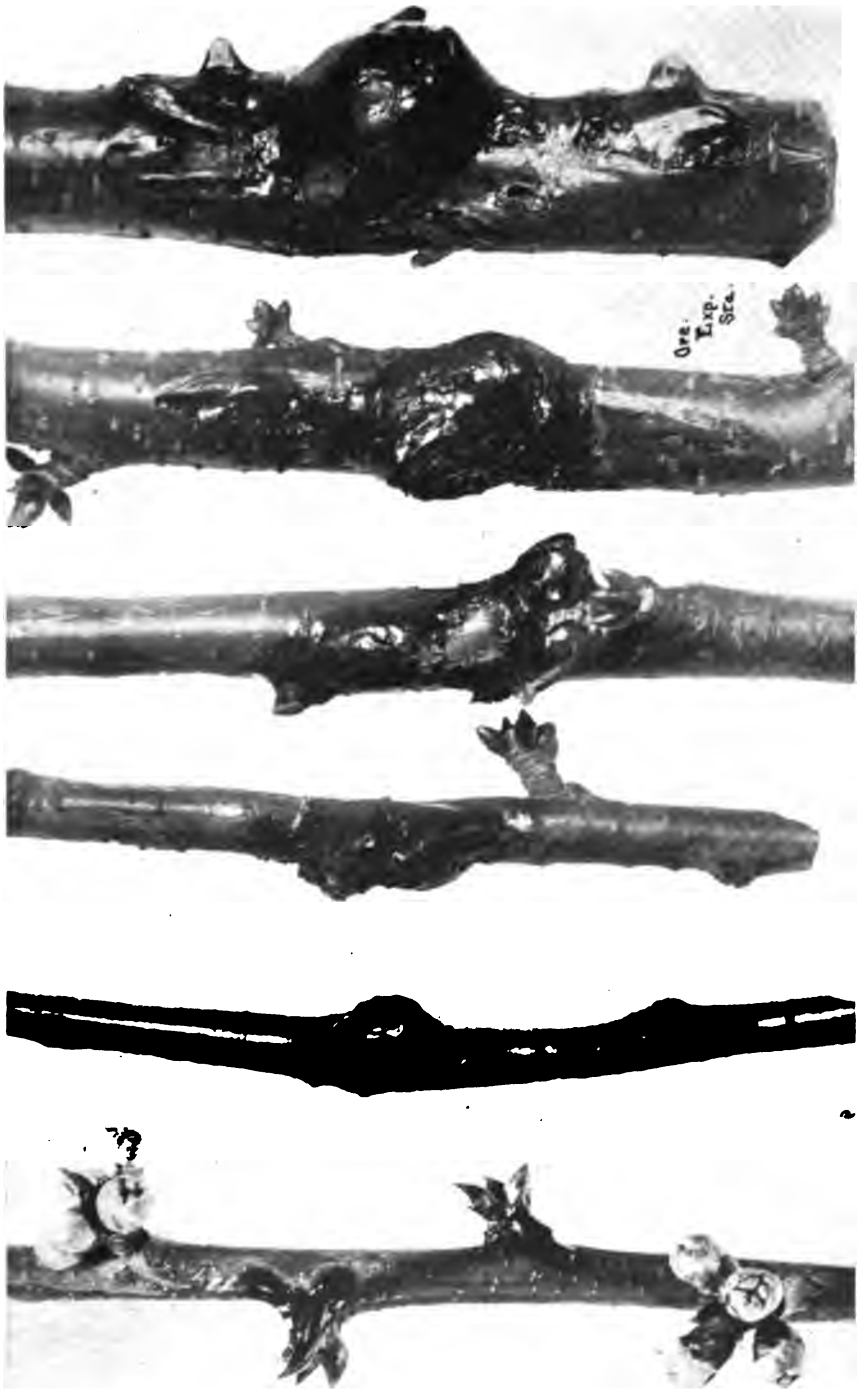

Fig. 5. A Series of Cherry Twigs Showing How Cankers May Develop Along the Branch, Spreading from the Bases of Blighted Spurs. A dead bud or spur was found near the middle of each canker. Bacteria like those causing the spur blight are in the advancing margins of such cankers.

the body of the tree, or to indicate just what part they play in its spread. The possibility of their being causative agents seems, however, to receive considerable support from the recent investigations.

Experiments must be carried on over a number of years before the nature of the disease can be demonstrated beyond a doubt, or recommendations for its control can be made with assurance. The relation which climatic and soil conditions, the attacks of insects or fungi, and the methods of cultivation have to the disease, must be studied thoroughly. This will take time and the cherry grower must not be impatient.

Prevention and Control

More important in the eyes of the practical orchardist than the cause, is the remedy for the disease.

Resistant Stocks and Varieties

The Mazzard Cherry as a Stock

Attention has been called to the fact that winter injury and unfavorable soil conditions may have a great deal to do with the appearance of gummosis in the cherry. It may be that the more serious phases of the disease cannot occur without a previous injury or weakened vitality due to some such factors. It is well known, both in this country and abroad, that the so-called Black Mazzard cherry is generally much hardier and less liable to suffer from adverse conditions than are the cultivated varieties. Hence, seedling Mazzards have come to be much used in Europe as stocks upon which to graft the commercial sweet varieties. In this country also the Mazzard is coming to be recognized as a sturdy stock which unites with the sweet cherries better than the Mahaleb. A point in favor of the Mazzard as a stock is that it seldom "gums." To make use of Mazzard stock and to graft or bud on the limbs the variety desired, gives trunk, crotch and limb bases that are practically free from trouble. If the disease then appears in the top, it cannot involve the entire tree and experience seems to show that the branches are much less liable to suffer from gumming when the body of the tree is clean.

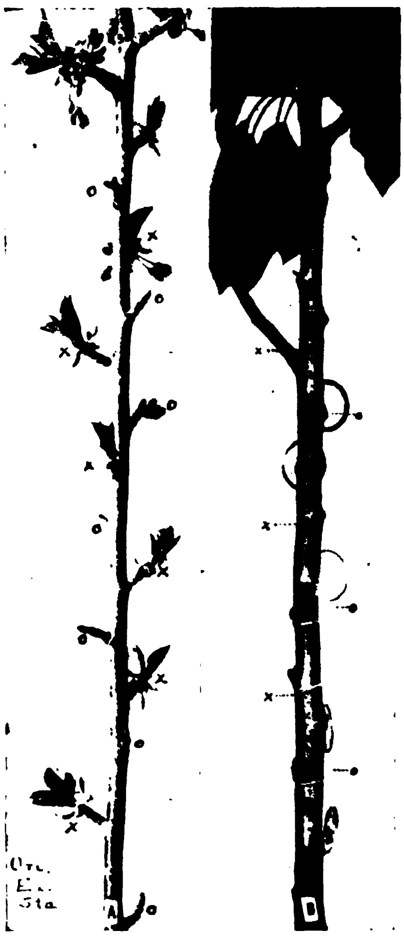

Fig. 6. The Results of Artificial Inoculation with *Ps. Cerasus*. (O) Indicates an inoculation. (X) A check puncture with sterile needle. A. Blighting of inoculated spurs. Checks opening normally. B. Gum exuding at points of inoculation on the body of two-year-old tree. The check punctures healed.

Examination of orchards aggregating some thousand trees supposed or known to be top-grafted upon Mazzard stocks showed 80 to 91 per cent free from any indication of disease on the trunks where orchards not upon this stock were found, to have, in some case, over 60 per cent and in one case over 80 per cent of the trunks badly cankered or killed by the disease. The writer is convinced that the use of the Mazzard as a stock on which to limb-graft or bud the other varieties, is a thoroughly practical way of protecting the cherry from this disease in its most damaging form. Figs. 8 and 9 are illustrations of this method.

Other Resistant Stocks

Various other stocks, including the Morello, the Dukes and a native cherry (*Prunus demissa*) have been recommended as hardy and resistant stocks on which to work the sweet cherry, but until these have been tried out further, the writer strongly advises the use of the Mazzard on account of the present evidence in its favor. A word of warning should be given here against unscrupulous dealers who sometimes palm off seedlings of doubtful lineage as Mazzards. There are, however, reliable nurseries from which satisfactory stock may be obtained.

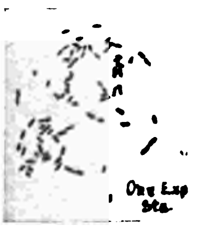

Fig. 7. Bacteria Which Induces Gumming of the Cherry. Magnified 500 Diam.

The Lambert Cherry

The three varieties of sweet cherries most extensively grown for commercial purposes in Oregon are the Royal Ann, Bing and Lambert. These are all subject to gummosis, but the Lambert has had the reputation of being less seriously affected than the other two. Observations in orchards in different sections seem to substantiate the general opinion.

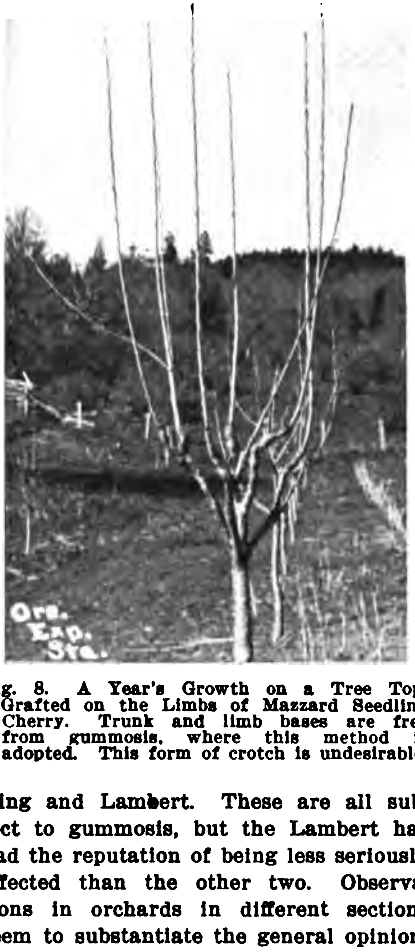

Fig. 8. A Year's Growth on a Tree Top-Grafted on the Limbs of Mazzard Seedling Cherry. Trunk and limb bases are free from gummosis, where this method is adopted. This form of crotch is undesirable.

Table Showing the Relative Effects of the Disease Upon Royal Ann, Bing and Lambert Trees in an Orchard near Salem, Oregon

Variety	Total number trees	Totally destroyed	Half destroyed	Badly diseased	Moderately diseased	Slightly diseased	Unaffected
Royal Ann	259	37%	13%	22%	27%	1%	0%
Bing	222	36%	15%	24%	24%	1%	0%
Lambert	259	13%	8%	9%	36%	31%	3%

The argument in favor of the Lambert in this orchard is striking.

In budding or grafting the susceptible varieties, it is a matter of good sense to select scions or buds from trees which seem particularly healthy and free from gummosis. In nearly every badly infested orchard there are trees of the Royal Ann or Bing varieties which seem to be healthier and freer from disease than the rest. Such may, perhaps, be more resistant than their neighbors, and

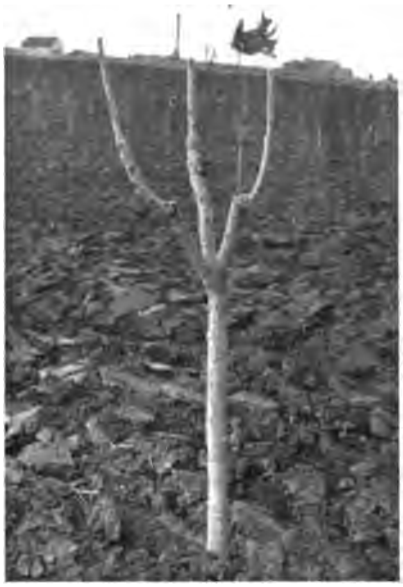

Fig. 9. Top-Budded on Mazzard Seedling and Headed Back to Produce Stocky Growth. The mazzard body is gummosis resistant. This form of crotch is undesirable.

that resistance may possibly be transmitted by the scion.

Cultivation

Thorough cultivation in the early part of the season is beneficial to the cherry, but spasmodic or irregular cultivation is considered harmful. As far as cherry gummosis is concerned, a tree assisted by proper cultivation and making a vigorous and rapid growth as a result, has a better chance to recover from and outgrow the trouble than a weak tree.

Cutting Out the Disease

The most successful method of treatment in practice among careful cherry raisers consists in the thorough cutting-out early in the season of all diseased, discolored and gum-soaked bark. Persistent watch is kept by frequent inspections and as soon as new diseased spots are discovered, they are cut out. Where this has been conscientiously done, and the injuries have been cut out before getting very large, the recoveries have often been rapid and the damage from the disease rather small. In cutting out, it is important that all the tissues which are in any degree affected should be removed. The wound thus made should be sterilized, preferably by the application of a solution of corrosive sublimate (1-1000); when dry, large wounds should be coated with walnut grafting wax* as a protection against the entrance of destructive wood-rotting fungi. It is often impossible to discover at once all the affected tissue around a gum exudation or canker, and a second or third cutting-out may have to be made during a season, but persistence will be rewarded in most cases by a rapid healing of the wound through the growth of new callus tissue over it. Care should be taken not to remove any more of the living and healthy tissues than is necessary in cutting out the disease.

Where a small branch is affected, it is often better to remove it entirely and allow a healthy one to take its place. In young trees it is strongly recommended to remove all blighted spurs and cut away discolored tissues that spread out from their base; since our investigations lead us to suspect that many of the serious cankers originate in this way.

Spraying seems to be practically useless as a means of control for cherry gummosis. Slitting of the bark has been recommended by many growers, but we cannot see that much benefit results except where a gum pocket is opened and the gum is prevented by release of pressure from spreading under the bark. On the contrary, where trunks or limbs have been slit deeply, bad wounds are sometimes produced, and instances of apparent spreading of the disease along the slit argue against the practice.

Other recommendations with regard to treating the diseased trees have been made by various growers. The cutting out of the cankers, however, has resulted in local benefit in so many well-authenticated instances under the writer's observation, that he does not hesitate to urge growers to adopt this practice. Although it takes time and patience, it pays in the end. The time to begin is when the trees are very young. Small cankers can be easily cut out, but an old tree full of disease is an almost hopeless case to work on.

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* The formula for making Walnut Grafting Wax is given in the Oregon Agricultural Experiment Station Bulletin No. 111, p. 96. See under Walnut.

Summary of Recommendations

1. Use a resistant stock like the so-called Mazzard cherry, and graft or bud into the branches to secure a trunk and crotch practically free from gummosis.

2. The Lambert cherry is recommended as being somewhat more resistant to the disease than the Royal Ann and Bing varieties.

3. Good cultivation in the spring is urged as promoting a vigorous and healthy growth and rendering the trees more likely to resist the spread of the malady.

4. The cutting out of diseased tissue and sterilizing of the wound will check the development of cankers in many cases, especially if taken in the earliest stages. New orchards should be carefully inspected for several years and all affected spots treated as soon as discovered.

A Partial List of Important Works Relating to Cherry Gummosis

Aderhold, R. *Ueber das Kirschbaumsterben am Rhein, seine Urschen und seine Behandlung.* Arb. K. Gsndhtsamt., Biol. Abt. 3, No. 4, 1903.

Aderhold, R., and Ruhland, W. *Der Bacterienbrand der Kirschbaume.* Arb. K. Gsndhsamt. Biol. Abt. 5, p. 293, 1907.

Beijerinck, M. W., and Rant, A. *Sur l'excitation par traumatisme, le parasitisme et l'ecoulement gommeux chez les amygdalees.* Arch. Neerland. Sci. Exact. et Nat., Ser. 2, 11, p. 184, 1906.

Brzezinski, P. J. *Etiologie du chancre et de la gomme des arbres fruitiers.* Compt. Rend. Acad. Sci. 134, No. 20, p. 1170, 1902.

Butler, O. R. *A Study on Gummosis of Prunus and Citrus.* Ann. Bot. 27, No. 97, p. 107, 1911.

Frank, A. B., and Kruger, F. *Das Kirschbaumsterben am Rhein.* Deut. Landw. Presse. 1899, p. 249.

Griffin, F. L. *A Bacterial Gummosis of Cherries.* Science N. S. 34, No. 879, p. 615, Nov. 3, 1911.

McAlpine, D. *Fungous Diseases of Stone Fruit Trees in Australia.* Bul. Dept. Agr. (Victoria), 1902, p. 67.

Mikosch, K. *Untersuchungen uber die Entstehung des Kirschgummi.* Sitzber. K. Akad. Wiss. (Vienna), Math. Naturw. Kl. 115, No. 6, p. 911, 1906.

Prillieux, E. *Etude sur la formation de la gomme dans les arbres fruitiers.* Compt. Rend Acad. Sci. 78, p. 135, 1874.

Sorauer, P. *Untersuchungen uber Gummifluss und Frostwirkungen bei Kirschbaumen.* Part 1, Landw. Jahrb, 39, p. 259, 1910. Part 2, Landw. Jahrb. 41, p. 131, 1911.

Die Back

Cherry trees are subject to injury from unfavorable conditions of soil, moisture, etc. As a result of such injuries the trees frequently die back from the top and suffer severely in this way.

This trouble can be controlled only by planting on soil which is particularly suited to the cherry and by determining the best root stock for any given type of soil or locality.

Trees in which die back and gummosis are produced by unusual climatic conditions should be cut back in the top to sound wood, and have the trunks protected from sunburn by whitewash or wrapping.

Fruit Drop

Fruit falls to the ground while small and undeveloped. The trouble is common to many fruits and is due to conditions of climate which lie outside of ordinary control, or to lack of proper pollination, which may be controlled by planting suitable varieties for cross-pollination. Rains occurring at blossoming time or frost at a critical time may have this effect.

R. E. Smith,
California Experiment Station, Bulletin 218.

Leaf Curl or Witches' Broom

Exoascus cerasi

H. S. Jackson

This disease is quite common in the Northwest, but is not yet very serious. It is caused by a fungus, *Exoascus cerasi*, which attacks the branches. The affected branch is not killed, but the presence of the fungus stimulates it to an unnatural and prolific formation of twigs, resulting in the peculiar "witches' broom" effect. These witches' brooms may be large or small, and are especially conspicuous at blossoming time, since they produce few flowers or none at all, while the leaves appear sooner than those on the normal parts of the tree. These leaves, which are penetrated by the fungus, are reddish in color and somewhat wrinkled or wavy. Not long after they become fully expanded the spores of the fungus are produced all over the surface and the affected leaves fall prematurely.

Control

Since the witches' broom produces no fruit, and is a drain on the rest of the tree, and a source of new infections, we recommend that the affected branches be cut off, a few inches below the diseased portion, and destroyed.

Leaf Spot or Shot Hole

Cylindrosporium padi

H. S. Jackson

There are several leaf spot and shot hole diseases which are more or less common on various stone fruits; but the greater part of this sort of injury on the cherry and plum is due to the fungus called *Cylindrosporium padi*. The trouble caused by this organism on the Pacific coast is not usually severe enough to alarm growers, but there is reason to think that the extent of damage is underestimated. While the amount of leaf area which is destroyed by the fungus is generally not very extensive, the presence of the shot hole spots on the leaves often results in partial defoliation, and in bad cases, even in total defoliation of the tree. This is naturally a severe check on its development. At the points where the infections take place, a small brownish spot appears. This enlarges, and may be surrounded by a reddish border. After a time, the dried center of the spot becomes detached from the margin and falls out, leaving the shot hole effect. On some varieties of cherries the center does not drop out, however, as it does in our common sweet varieties. The disease is spread by means of spores produced in the affected spots and the fungus probably survives the winter in the fallen leaves from which, in the spring, spores are carried to the new foliage by the wind.

Control

The disease can be largely controlled by spraying. According to W. M. Scott, of the United States Department of Agriculture, who experimented in Illinois, self-boiled lime-sulphur 10-10-50, commercial lime-sulphur 1-40, and a weak Bordeaux mixture 2-4-50, are equally effective. Recent experiments by Butler in Wisconsin indicate, however, that Bordeaux is more effective than commercial lime-sulphur. It is recommended that the spray be applied three times: First, half way between blossoming time and the ripening of the fruit; second, just after picking; third, about one month after the second.

MUSHROOM ROOT ROT. See under *Apple*.

POWDERY MILDEW. See under *Peach*.

SHOT HOLE. See *Leaf Spot*, this section.

WITCHES' BROOM. See *Leaf Curl*.

CHERRY PESTS

BUD MOTH, EYE SPOTTED BUD MOTH. See under *Apple Pests*.

CHERRY APHIS. See *Aphids*.

Cherry Fruit Fly

Rhagoletis cingulata Loew

H. F. Wilson

Unfortunately, due to the habits of this insect, the grower does not know of its presence until the cherries are mature. If left to hang on the tree or uneaten for several days after picking, the presence of a full grown maggot is shown by the rotting and shrinking of one side of the fruit, and about that time the maggots leave the fruit for the purpose of going to the ground, where they pupate and remain over winter. The adult fly resembles the common apple maggot very closely and may prove to be the same insect. Somewhat smaller than the common housefly, the general color is black with lateral borders of thorax light yellow, and head and legs yellowish-brown. Wings with five, more or less distinct black bands, three of which lie angled to each other and join at the front edge of the wing near the tip. These flies deposit the eggs from which the yellowish-white maggots or "worms" issue and work in the fruit around the pits. This causes a kind of rotting and softening of the fruit on one side.

Just when the fruit is entered is not known, but the life of the maggot is probably about three weeks, and as the mature stage is reached about the time the fruit is ripe, some idea of the time they enter the cherry may be gained. Since the larvae remain in the fruit for a short time after it is picked they may be distributed quite a distance in fruit. The adults are not strong fliers and can hardly do more than to spread from tree to tree or at the most from orchard to orchard.

Remedies

No very satisfactory remedy is at present known, although a great many have been tried.

Cherry Fruit Sawfly

Hoplocampa cookei Clarke

The cherry fruit sawfly is a native of California and other Pacific coast states and has been known since 1883 in the Suisun valley, California.

Considerable damage to young cherries has been done in various sections by the larvae of this insect and occasionally, at least, control measures may be necessary.

The presence of the insect may be told by the small round holes bored in the young green cherries, many of which soon drop to the ground.

The larvae are small, white and average about one-fourth of an inch in length. The adults are four-winged insects, black with brownish or reddish appendages, about one-eighth of an inch long.

Control measures have not been thoroughly perfected but two applications of arsenate of lead at the rate of four to five pounds to 100 gallons of water, the first application to be made shortly before the blossoms open and the second about 10 days later, have proven effective. Fall plowing is also recommended to kill the larvae and pupae in the soil while a distillate-oil emulsion and nicotine spray is recommended to kill adults at time of egg laying.

The insect has been reported as occurring in the Suisun valley, El Dorado and Nevada counties, California, and at Medford, Oregon, where it is confined to a very small area.

The orchard fruits attacked are cherry (sweet and sour), prune, plum, peach and apricot (the peach and apricot only occasionally).

The females appear about the time the Black Tartarian cherries are in bloom. The eggs hatch about the time the petals fall.

E. O. Essig

Cherry Leaf Beetle

Galerucella cavicollis

In September a small, dark red beetle, less than one-fourth inch long, may be found feeding on the leaves of cherries. The antennae and parts of the legs are black. It is partial to the wild cherries, and also feeds on peach and plum. This is the cherry leaf beetle. It may be destroyed in the fall by spraying with arsenate of lead, three to five pounds in 50 gallons of water.

H. A. Gossard

Cherry Scale

Eulecanium cerasorum Ckl.

General Appearance

The full-grown scales are exceedingly large, often obtaining a height of three-eighths of an inch, though the average is slightly over a quarter of an inch. The general shape is hemispherical, and the bodies are very irregular and lobed. The general color is rich brown, mottled with creamy white. The markings are more or less regular and constant. The entire surface is highly polished and shiny.

Food Plants

This scale works upon the branches of cherry and pear trees, collecting in such great numbers as to do considerable damage.

Control

Same as for black scale on deciduous fruit trees or for the European fruit scale.

E. O. Essig

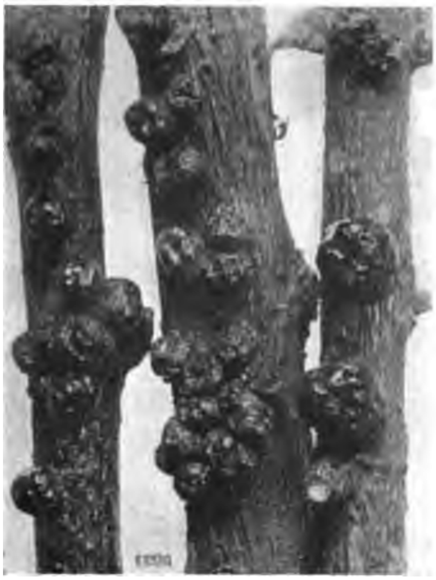

Fig. 1. The Cherry Scale. *Eulecanium cerasorum* (ckll) on Pear. Slightly reduced. (Original.)

Cherry and Pear Slug

Caliroa cerasi Linn

H. F. WILSON

This insect is a common pest of pear, cherry, plum and other fruit trees, and although not hard to control often causes considerable damage. The name "slug" is applied on account of the slimy black exudation with which the larva surrounds itself.

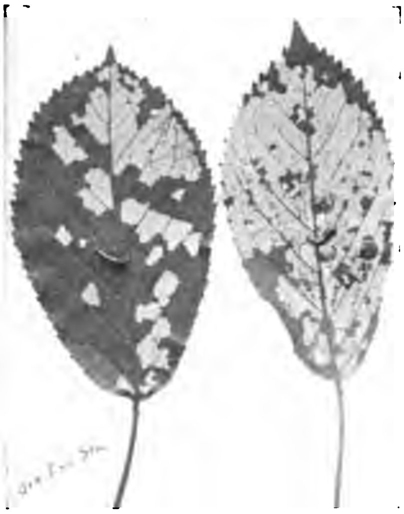

Fig. 1. Cherry Leaves Injured by Slugs.

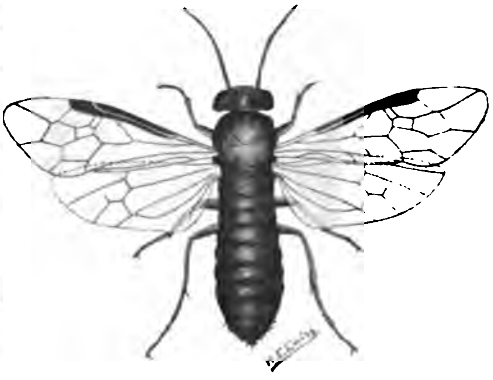

Fig. 2. Adult of Cherry and Pear Slug.

It appears to be a native of Europe and was known as a pest as far back as 1740. In America the distribution seems to occur with the areas where its principal host plants are found. A large number of trees, including forest and orchard trees, have been reported as attacked by this insect, but cherry, pear and plum are said to be the favorite plants.

When present in any locality the larvae soon make themselves familiar to the fruit grower both by their appearance and by the injury which they do.

In the Northwest we have found but two complete broods with some indication that there may be a partial third. The first adults appear in early spring, but for some reason the eggs do not develop or are not laid until May or June; as soon as they hatch the young larvae begin feeding on the leaves and from that time until the leaves drop the slugs are present in varying numbers. Most of them, however, are found in two distinct periods: the larvae of the first generation appear more abundant during June and July; the larvae of the second generation are most numerous during August and September.

Webster has worked out the following schedule for Iowa:

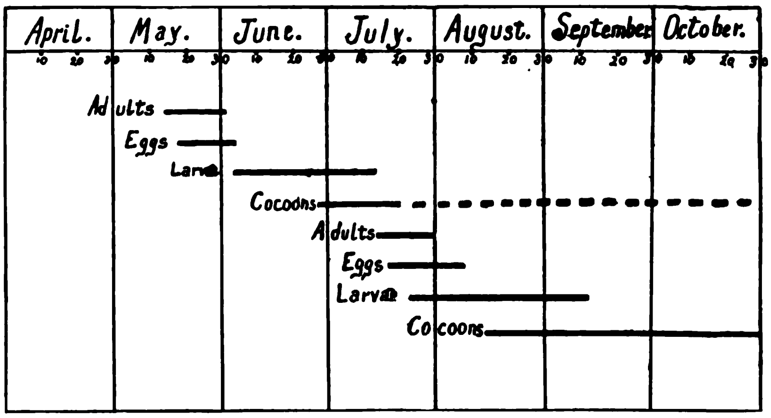

Fig. 3. Diagram of Life Cycle. (Iowa Bulletin 130.)

When present in large numbers, they soon cause the leaves to become brown and the trees to look as if they had been badly scorched by fire. The adult insect is a small shining black fly with four smoky transparent wings, the smoky appearance being caused by a dusky band across the middle of the wings. On account of the saw-like ovipositor with which the insect makes incisions into the leaves, this insect and a number of closely allied species are known as saw flies.

Life History and Habits

Searching out a suitable place, the adult fly pushes the ovipositor rather slowly into the under surface of the leaf and makes a small oval-shaped pocket into which the egg is placed by means of the ovipositor. When the pocket is being made the tissues are so cut as to prevent their growing around the egg and destroying it or preventing the escape of the larva.

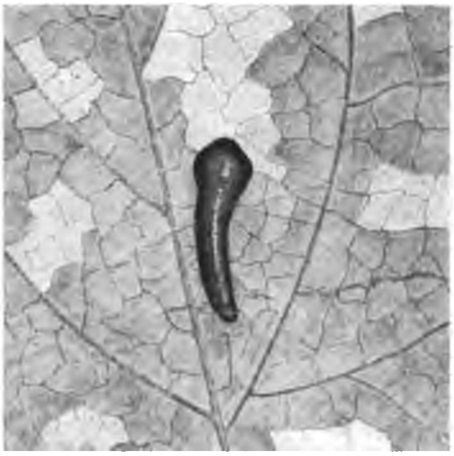

Fig. 4. Larva of Cherry and Pear Slug. —*After Ewing.*

The egg is almost colorless and is flattened on the lower side. As soon as the eggs hatch the young larvae make their way to the upper surface of the leaf and begin feeding. At first they are yellowish white in color and without slime. In a very short time, however, as the slime spreads over the body, they change to a dirty green and have more the appearance of a slug than of an insect. Immediately upon hatching they begin feeding on the upper tissue of the leaf, eating out numerous small patches, so that a number of slugs working on the same leaf will leave nothing but the dead brown skeleton of veins.

After completing their moults the larvae do not feed any more, but crawl or drop to the ground, work their way into the soil from one to three inches and pupate. After moulting the last time, they do not again assume the slimy protection, and instead of being green they are of a yellowish orange color with two minute black eyes. After the larvae crawl into the ground an oval cell about five-tenths inch long by three-sixteenths inch wide is made.

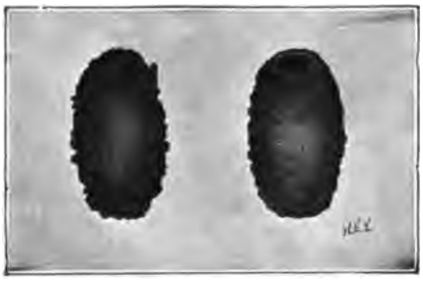

Fig. 5. Pupa Cases of Cherry and Pear Slug.

When disturbed these cells are very easily broken apart, a fact which might indicate that fall plowing can be used as a method of destroying the pupae, according to Marlatt.

"During the heated season of July and August the transformation from the larval to the adult insect is quite rapid, the pupal stage being assumed in from six to eight days, and the adult flies transforming and digging out through the soil some 12 or 15 days after the larva entered it."*

According to the studies of Peck and Marlatt some of the larvae of this spring brood remain over in the soil until the following spring. This seems to be a provision of nature to carry the species over, should anything happen to exterminate the regular line of succession, such as lack of food, unfavorable climatic conditions, etc.

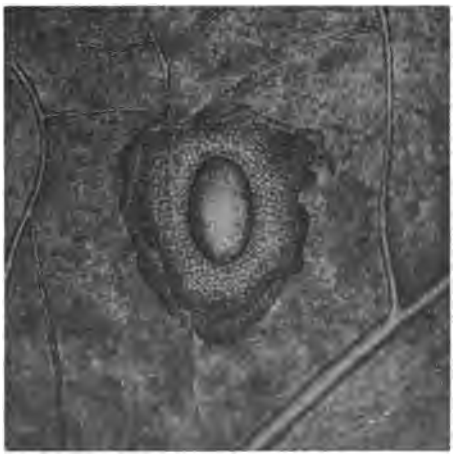

Fig. 6. Egg of Cherry and Pear Slug.
—*After Ewing.*

Natural Enemies

Although furnished with a sticky covering which acts as a repellant against all enemies, the insect is not entirely free from insect enemies, and in Europe some half dozen insect parasites have been reared from it. In this country a minute fly is said to sting the egg through the upper leaf tissue.

Remedies

White hellebore, one pound to 50 gallons of water. No foliage is injured and the slugs are nearly all dead on the day following the application of spray.

"Black leaf-40" gives practically the same results as white hellebore and does not injure the foliage. "Black leaf-40" is more expensive to use than the hellebore.

Hellebore is the best remedy to use for cheapness, efficiency and lack of injury to the foliage. To get best results it must be fresh and free from adulteration.

Arsenate of lead is cheaper but does not kill as quickly and may injure the foliage.

CURCULIO. See under *Plum Pests.*

Divaricated Buprestis

Dicerca divaricata

A flatheaded borer found beneath the bark. May be treated the same as the flat headed apple tree borer, which see under *Apple Pests.*

Dogday Cicada or Dogday Harvest Fly

Cicada linnei

Deposits its eggs in the twigs of cherry and other trees. The musical notes or drumming of the male cicada during the middle of the day is a familiar sound during August and September. Injury by this insect is generally slight and it is scarcely necessary to trim out and burn the twigs containing eggs.

Emperor Moth

Callosamia promethea

Until late in September, full-grown caterpillars of the Promethea Emperor moth may be found feeding on the leaves of cherry, especially of the wild species. This is a large, bluish white, or bluish

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* C. C. Marlatt. U. S. Department Agriculture, Bureau of Entomology Circular 26, Second Series 1897.

green caterpillar, about 2½ inches long, with 4 yellow or red tubercles or horns on the thoracic segments, i. e., on the two posterior rings bearing feet; there is also a large horn of similar color on the back of the 12th segment, counting from the head. When full fed, the caterpillar draws the opposite edges of a good sized leaf together, thus making a kind of cylinder, except that the ends are closed, and within this it spins a very tough, light-colored cocoon. The stem of the leaf, enclosing the cocoon, is attached by a strong band of silken threads to the twig which produced it. So strong is this connecting band that it cannot be broken except by a very strong pull. The cocoons may be clipped from the trees and burned after the leaves have fallen. No other remedy than hand-gathering is needed when the worms are feeding.

H. A. Gossard,
Wooster, Ohio.

Ermine Moth. See under *Apple Pests.*

Fall Canker Worm

Alsophila pometaria Harris

Family Geometridae

General Appearance

In all of its stages this insect greatly resembles the spring canker worm *(Paleacrita vernata* Peck), but differs in that the larvae have three pairs of legs on the posterior half of the body instead of two and the bodies are more distinctly striped. The primary wings of the males also have an extra light band near the middle. The eggs are shaped like small flower pots, being smaller at the bottoms than at the tops, with distinct darker circles at the tops. They are deposited in regular clusters of from fifty to two hundred, standing side by side in exposed places.

Life History

The life history is practically the same as that of the spring canker worm, but the eggs are deposited in a compact mass and glued to the twigs and covered with hairs from the female's body in the late fall or during the milder portions of winter, as late as March. The young hatch about the same time as those of the spring forms and work about the same. The adults issue from October to December, or as late as spring, and immediately crawl up the trunks to deposit their eggs.

Food Plants

The foliage of the apple, prune, cherry, apricot and other fruit trees are attacked.

Control

Control measures as adopted for the spring canker worm may be used for this (See under *Apple Pests.*) Bands around the tree trunks will not prove as effectual, because of heavy winter rains, unless they are occasionally renewed. These barriers must be put in place during September and October and continued until spring.

E. O. Essig

Fall Web Worm. See under *Apple Pests.*

Frosted Scale. See under *Apricot Pests.*

Fruit Bark Beetle. See under *Apple Pests.*

Ivy or Oleander Scale. See *Apple Pests.*

Leaf Crumpler. See under *Apple Pests.*

Peach Borer. See under *Peach Pests.*

Pear Blight Beetle. See *Shot Hole Borer*, this section.

Pear Thrips. See under *Pear Pests.*

San Jose Scale. See under *Apple Pests.*

Scurfy Scale. See under *Apple Pests.*

Smaller Shot Hole Borer

Xyleborus saxeseni Ratz

H. F. Wilson

This little cylindrical beetle is quite similar to the shot hole borer in appearance, but is only about one-half as large. The burrows are also quite dissimiliar in nature, and on comparison can readily be distinguished.

The above species apparently works upon the same trees and under the same conditions as the larger species, and so far as we know, never enters perfectly healthy trees. The life history is not definitely known for the Northwest, but in general is about as follows:

The adults reach maturity in the spring

or summer, and making their burrows in some diseased tree deposit eggs which later hatch out into small white grubs. These are the larvae and remain in that stage through the summer and winter transforming to pupae and adults in the spring. The burrow, instead of being a series of short tunnels, is one large cavity with sides parallel and about the width of the full grown beetle. The sides extend straight up and down and the eggs are indiscriminately deposited in a single mass. It is believed that this insect attacks only unhealthy trees.

Shot Hole Borer or the Pear Blight Beetle

Xyleborus dispar Fabricus

H. F. Wilson

There is no evidence that shot hole borers attack healthy trees in the Northwest under ordinary conditions.

Contrary to all reports from Europe and other parts of the United States there appears to be but one brood in this section.

Classification

The *Scolytidae* or engraver beetles, constitute a large and important group of beetles, many of which are very destructive to forest trees. From an economic standpoint the members of this family may be divided into two general groups, those attacking healthy living plants and those attacking plants in a more or less sickly or *dying* condition. Observations made in the Northwest by the writer indicate that *Xyleborus dispar* is distinctly a member of the second group.

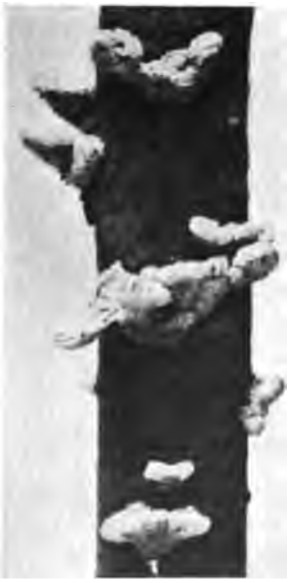

Fig. 1. Heart Rot Fungus (*Schizophyllum sp.*) in Cherry, Issuing Through Burrows of (*Xyleborus dispar*).

History

The widespread distribution of this insect in Europe would indicate its being native to that country. We can only theorize on the time and means of importation into the United States, but the time must have been several years prior to 1816. About this time the insect was attracting some attention in Europe and has continued to receive more or less attention by different writers up to the present date.

Distribution

This insect is found in nearly all parts of Europe and England and is gradually spreading into certain sections of Canada and the United States.

Occurrence in the Northwest

The first reported injury in the Northwest which was in Clarke county, Washington, came in 1901, where a grower thought that a great many prune trees were being killed by the beetles. At the same time the beetles were working in Oregon near the city of Portland. In looking over the many inquiries which have been received during the past ten years it is interesting to note the gradual spread of the insect up the Willamette valley until now it is at Junction city, a distance of 125 miles south of Portland.

At the present time the distribution extends through the lower part of the valley on both sides of the river as far as the foot hills. The infested territory is increasing quite rapidly and the borers will in time undoubtedly spread over the entire western part of Washington and Oregon. From Portland to Salem, Ore., a distance of 53 miles, they are very abundant across the entire valley, and few dying trees escape their attack.

Nature and Extent of Injury

The real injury caused by these beetles seems to be almost, if not entirely, secondary. Many of our orchardists upon finding sick and dying trees with the shot hole borer working in them have attributed the cause to the beetles.

By visiting many of these places and explaining to the orchardist the true conditions, we have convinced them that the trees were suffering from some fungus disease or improper soil condition.

The beetles may help to kill the trees and in some cases might cause the death of trees which would have recovered from the disease had the beetles not been present. In the case of young trees, only one or two years old, this could readily happen, as the burrows extend almost entirely around the trees and close to the inner bark. (For example see Fig. 2.) In the summer, after the beetles have completed the burrows, such trees can easily be broken off at the point of injury.

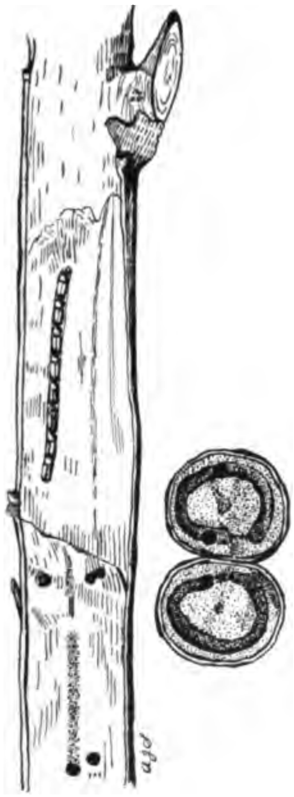

Fig. 2. The Shot Hole Borer. Burrow in young cherry tree and adults in hibernation.

Life History

The winter is spent in the adult stage. Both males and females hibernate in the burrows from July and August until the following spring. They emerge during the last of March and first of April and migrate to sick and dying trees, where the burrows of that season are to be made. The entrance hole is usually made about a bud scar or in some roughened place. The beetles have no trouble in picking out the sick trees.

The Adult

The adult bores directly through the bark and into the wood tissue for a quarter of an inch or more and then begins the construction of branch burrows extending at right angles to the main burrow and with the grain of the wood. These channels are all about one-twelfth inch in diameter and from three-quarters to two and a quarter inches in length.

The Egg

The eggs may be found from the second week in April until the middle of June. When first deposited they are oblong in shape and pearly white in color. They measure 1 mm. in length by 0.06 mm. in diameter and will stand considerable rough handling. There seems to be no regularity in the egg deposition, as there may be from one to seven in each chamber of the burrow, placed without discrimination.

The burrows are not all made at once but are completed in sections, the female spending her time meanwhile between depositing eggs and resting near the entrance to the burrow. When the first branch chamber is finished the mother beetle deposits in it from one to seven eggs, and the fungus food of the larvae having been arranged for, she closes the entrance with frass and pays no more attention to it. The entire burrow is usually completed by the middle of May and then the mother beetle returns to the entrance where she stands guard until the following winter.

In the fall, when the beetles have matured, if some of the burrows are opened, both males and females can be found, the females usually outnumbering the males four or five to one.

During the hibernation period the adults apparently do not feed, as the fungus upon which the larvae feed is almost entirely absent in burrows opened at various times during the winter and there is no evidence of wood burrowing.

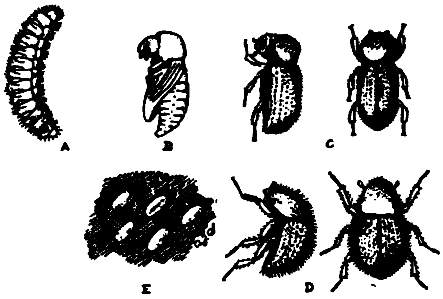

Fig. 3. The Shot Hole Borer (*Xyleborus dispar*). A, Larva; B, Pupa; C, Adult Female; D, Adult Male; E, Eggs.

Host Plants

This insect will apparently work and develop in all kinds of deciduous fruit and forest trees and has been reported as working in conifers. The following fruit trees are reported: apple, pear, quince, cherry, prune, plum, hawthorn, apricot, white hawthorn, grape and pomegranate. Nearly all writers on this subject agree that the beetles favor dying trees to healthy ones and several of them state that freshly cut logs and stumps are excellent breeding places. In the Northwest we have found them working in cherry, prune, apple, pear and chestnut. Cherry and prune are attacked more because those two trees appear to be more subject to diseased conditions than any of the others. Many cherry trees, especially young ones, die each year from the disease known as cherry gummosis. Prune trees are found growing in all manner of places and a great many in unsuitable surroundings. Naturally many of them succumb, and in addition there seems to be a disease similar to that of the cherry which destroys a great many. Both of these fruits develop what is commonly known as sour sap, a condition known to be favorable for the development of the fungus food upon which the larvae feed.

An occasional apple orchard is found infested, and I have observed a few pear trees showing attacks of this insect.

The Food of Xyleborus Dispar

The fungus upon which the larvae feed is evidently carried to the burrows by the females, since it appears in each burrow almost as soon as started.

The earlier entomologists seem to have been in doubt as to the nature of the food found in the brood chambers. Hubbard, 1897, gives a discussion on this fungus. He writes as follows:

"The ambrosia does not make its appearance by accident or at random in the galleries of the beetles. Its origin is entirely under the control of the insect. It is started by the mother beetle upon a carefully packed bed or layer of chips, sometimes near the entrance, in the bark, but generally at the end of a branch gallery in the wood. In some species the ambrosia is grown only in certain brood chambers of peculiar construction. In others it is propagated in beds, near the cradles of the larvae. The excrement of the larvae is used in some and probably in all the species to form new beds or layers for the propagation of the fungus.

"There must be present a certain amount of moisture or sap, and the sap in most species must be in a condition of fermentation."

As the fungus develops the growth forms into little globules containing the spores.

"The young larvae nip off these tender tips as calves crop the heads of clover, but the older larvae and the adult beetles eat the whole structure down to the base, from which it soon springs up afresh, appearing in little white tessellations upon the walls."

Natural Enemies

Eichhoff, 1881, reports *Calydium filiforme*, *Oxylaunus caesus* and *Hypophlosus bicolor* as found in the chambers of *Xyleborus dispar* and probably feeding upon the brood and eggs of the latter.

Schwarz, 1891, reports finding *Bactridium cavicolle* in breeding cages of *Xyleborus dispar*, and supposes that they are predacious on the larvae and eggs of this insect. We have as yet found no natural enemies of this insect in Oregon, probably owing to its recent importation.

(See also Lesser Shot Hole Borer, this section.—Ed.)

Bibliography of More Recent Literature

1872—Hartig, Th. Ambrosia des Bostrichus dispar. (Allgem Forst u. Jagd. Zeit Neu, Folg. 13. Jahrg. S. 73-74. Frankfort a. m., 1872.)

1873—Schiodte, J. C. Fortegnelse overde i Danmark levende curculiones Naturhistorisk Tidsskrift ved J. C. Schiodte 5 Raekke. 8 Bind s. 47-110. Kjobenhavn. 1872-1873, p. 103.

1879—Eichhoff, W. Rates, Descriptio, Emendatio eorum Tomicinorum, p. 320.

1895—Judeich, Dr. J. F. und Nitsche, Dr. H. "Lehrbuch der Mitteleuropaischen Forstinsektenkunde," Vol. I, pp. 549-551.

1896—Smith, E. F. Ambrosia (Amer. Nat. Vol. 30 [1896], No. 352, pp. 318, 319). Some notes on the fungus food of Xyleborus.

1896—Hubbard, Henry G. Ambrosia once more. (American Naturalist, Vol. 30, p. 493, June [general]).

1897—Hubbard, Henry G. Ambrosia Beetles of the U. S. (Some miscellaneous results of the work of the Division of Entomology, U. S. Dept. of Agri., p. 22 [Bul. 7, Bureau of Entomology]).

1898—Omerod, E. A. "A Handbook of Insects Injurious to Orchard and Bush Fruits," p. 185.

1899—Harvey, F. L. and Munson, W. M. Apple Insects of Maine. (Bul. 56, Maine Agri. Exp. Sta., p. 112.)

1899—Lugger, Otto. Beetles Injurious to Fruit-Producing Plants. (Bul. 66, Division of Entomology, Minn. Agri. Exp. Sta., pp. 310-312.)

1902—Cordley, A. B. 14th Ann. Rept. Oregon Agricultural College, pp. 60-61.

1902—Fletcher, James. Report of the Entomologist and Botanist for 1901. (Ann. Rept. Canada Experimental Farms for 1901, p. 249.)

1905—Fletcher, James. Report of the Entomologist and Botanist for 1904. (Ann. Rept. Canada Experimental Farms for 1904, p. 240.)

1905—Beauverie, J. Le Bois. Ganthier-Villars, edit, Paris.

1909—Beauverie, J. Sur une maladie des pêchers dans la vallie du Rhone. (L' Horticulture Nouvelle, Lyon, 1909.)

1910—Beauverie, J. Les Bois Industriels, O. Doin, edit, Paris.

1910—Beauverie, J. Les Champignous dit Ambrosia. (Ann. Des Sciences Naturalles Botanique. Tome XI, No. 1, pp. 31-75.)

Spring Canker Worm. See under *Apple Pests*.

Tent Caterpillar. See under *Apple Pests*.

Tussock Moth. See under *Apple Pests*.

Walnut Scale. See under *Walnut Pests*.

White Peach Scale. See under *Peach Pests*.

Chinese Apple. See *Apple, Botany of*.

Choke Berry. See *Apple, Botany of*.

Chestnut Culture

Commercial chestnut culture is beginning to take a place among the permanent horticultural industries of the United States. The enormous annual crops of small, sweet chestnuts, and the lack of appreciation of the value of the chestnut in the dietary of Americans have held back the systematic improvement of the American type into large, desirable kinds, and discouraged, for many years, the introduction of improved varieties from Europe or Asia. A few European seedlings have been growing for nearly a century within fifty miles of Wilmington, Delaware, and Philadelphia, Pennsylvania, where the history of the European chestnut in America largely centers. In all this time, but few orchards or groves have been developed, and only within a few years have any of the seedlings been selected for commercial propagation.

History of the European Chestnut

The European chestnut, which is popularly called the "Spanish Chestnut," was introduced into the United States, not for economic purposes, but by individuals who wished to determine its adaptability to their private estates. Nearly all of the varieties now in propagation are descendants from the French "Marrons," and the appellation "Spanish" is an anomaly. New varieties are not being extensively introduced from Europe at present, but many persons have planted the nuts of the best naturalized kinds, like the Paragon, hoping to discover among the variable progeny, seedlings that are superior to their parents.

The earliest history of the European chestnut, in America, is hidden in obscure book notices, or in the note books of those who were interested in early American agriculture.

The introductions that mark the beginning of the general dissemination around Wilmington and Philadelphia were those of Eleuthere Irenee du Pont de Nemours, who, with his family, emigrated from France to America in 1799, and after a residence at Bergen Point, N. J., where he took much pleasure in propagating a number of European seeds and plants received from France. It can be inferred from Mr. du Pont's journals and correspondence, that he planted a number of French chestnuts in his garden at Eleutherean Mills, Christiana Hundred, near Wilmington, Delaware, in the spring of 1803, and it is certain that a considerable number of trees became established and flourished there, some of which are still in existence.

To many of his friends he sent nuts or scions from his famous French Marrons, and from these chestnuts a multitude of seedlings sprang up and are still standing along the fence rows or in the gardens.

A few of these surviving seedlings, by attracting the attention of enterprising nurserymen, have thereby entered the variety ranks, but there are numbers that have long lain in obscurity, which, if introduced, might justly claim varietal distinction. The history of the named varieties is much confused, for it is based, in many cases, on the uncertain memory of those who have been longest acquainted with the trees.

History of the Japanese Chestnut

The development of the Japanese chestnut in America is the outcome of the systematic efforts of a number of nurserymen to introduce varieties from Japan, or to produce valuable seedlings from those already naturalized.

In 1876, the S. B. Parsons Co., Flushing, N. Y., imported a few trees from Japan through the late Thomas Hogg. (Fuller). The trees, Mr. S. B. Parsons writes, were cultivated with no special care, but the large nuts soon attracted attention. The *Parsons' Japan* was well known a few years ago, but at present no important varieties are cultivated from this importation.

In 1882, the late William Parry, Parry, N. J., imported one thousand grafted trees from Japan, and from them a single tree, the *Parry*, was finally selected, and has since become the progenitor of more valuable kinds than any other Japanese chestnut. The Parry Bros., who succeeded William Parry, have selected a large number of seedlings of the *Parry* for commercial propagation.

Luther Burbank, Santa Rosa, California, planted a box of the largest Japanese chestnuts sent him from his collector in Japan in 1886, and from over ten thousand bearing seedlings, after years of critical study and elimination, recently selected three as worthy of perpetuation—the Hale, the Coe, and the McFarland, now owned and propagated by J. H. Hale, South Glastonbury, Conn.

The Lovett Company, Little Silver, N. J., were active, at about the same time, in introducing the type through imported trees and nuts, and from the trees sent out by them, several meritorious kinds have been named by J. W. Kerr, Denton, Maryland, and J. W. Killen, Felton, Delaware.

A number of other firms have been introducing and distributing the nuts, but nearly all of the named varieties can be traced to the introductions of the firms mentioned.

The varieties of Japanese chestnuts have been considerably confused through the unfortunate practice of some who have sent out seedlings under such names as "Japan Mammoth," "Japan Giant," and "Japan Sweet." These names, as generally used, have no varietal significance, for chestnut seedlings vary as widely as apple seedlings.

Geographical Adaptability

We can give no definite data that will establish the geographical limits of the cultivated chestnuts. Experimental effort is needed to establish their range of adaptability. It is not improbable that their distribution will follow the areas of the American chestnut, falling short of its extension in certain localities, and extending beyond it in others. As a guide to the possible geographical adaptability, the range of the American chestnut, adapted from Sudworth's "Check List of the Forest Trees of the United States," is given.

"From Southern Maine to Northwestern Vermont (Winooski river), Southern Ontario, and southern shores of Lake Ontario to Southeastern Michigan; southward to Delaware and Southeastern Indiana, and on the Allegheny mountains to Central Kentucky and Tennessee, Central Alabama, and Mississippi."

(Hardy varieties of chestnuts will do well along the Pacific coast as far northward as Washington, according to Mr. A. A. Quarnberg, nut specialist, of Clarke county, Washington. The Japanese and French chestnuts shown in this article were grown by Mr. Quarnberg. Figs. 2 and 3.—Editor.)

Uses of the Chestnut

Before chestnut culture can become a prominent industry, there will need to be a larger appreciation of the uses to which the chestnut can be put. Popular sentiment will also need revising, so that the chestnut harvest will not be looked upon as public property, purposely grown for the benefit of the community at large. The chestnut industry, as a means of enlarging the food supply of the United States, is a horticultural phase that is worthy of serious consideration. In many European countries the chestnut is looked upon as a staple article of diet.

In France

Griffin says, that in France, "from the Bay of Biscay to Switzerland, there are large plantations, and almost forests, of chestnut trees." The nuts "are broad, large, and resemble the American horse-chestnut or buckeye *(Esculus hippocastanum)*, and are extensively eaten by human beings and animals." * * * "The poor people during the fall and winter, often make two meals daily from chestnuts. The ordinary way of cooking them is to remove the outside shell, blanch them, then a wet cloth is placed in an earthen pot, which is almost filled with raw chestnuts; they are covered with a second wet cloth and put on the fire to steam; they are eaten with salt or milk. Hot steamed chestnuts are carried around the city streets in baskets or pails; the majority of the working people, who usually have no fire in the morning, eat them for their first breakfast, with or without milk." * * * "These nuts are often used as a vegetable, and are exceedingly popular, being found on the table of the well-to-do and wealthy. They are served not only boiled, but roasted, steamed, pureed, and as dressings for poultry and meats."

"Chestnuts are made into bread by the mountain peasantry. After the nuts have been blanched, they are dried and ground. From this flour, a sweet, heavy, flat cake is made. It resembles the oaten cakes so popular among the peasants."

In Italy

In Italy, Bruhl says that the chestnut forms a considerable part of the diet of the people during the fall and winter, where they are generally eaten roasted. "They are also much eaten in a cooked state; often prepared like a stew, with gravy." He says, also, "the chestnuts are dried until they are as hard as dried peas, then shelled, after horses have been driven over them to crack the shells." The dried nuts can be shipped anywhere "and are said to be as good for cooking purposes as the fresh ones. These are also sold on the streets and eaten like peanuts."

In Korea

In Korea, Allen says, "By far the most common food nut is the chestnut, which almost takes the place with the Korean which the potato occupies with us. The chestnut is used raw, boiled, roasted, cooked with meat, made into confections, powdered and mixed with candy, and dried whole, in which latter condition it becomes quite sweet, but is apt to be affected by worms."

In Japan

According to Rein great quantities of chestnuts are raised in Japan, but there they are used less for human food than they are elsewhere. They are fed largely to swine. The latter practice may account for the poorer quality of the Japanese chestnut; quantity, rather than quality, being the desideratum among the Japanese. Sargent, on the other hand, in referring to the human use of the chestnut in Japan, disagrees with Rein, and says, "I have never seen chestnuts offered in such quantities in any American or European city as in those of Tokyo, and other Japanese towns."

The composition of the European chestnuts has been shown by Frear to be similar to that of wheat. By the same writer and by others it is stated that the chestnut is easily digested after the starch grains have been burst open and made less resistant to the attacks of the digestive fluids, by cooking.

Botanical Considerations

The botanical rank of the chestnut groups is much perplexed. Botanists are unanimous in according the European chestnut specific rank, but the Japanese and the American types are considered both as varieties and as species by various authors. Personally, I prefer to consider the three groups as distinct species, for as they are growing in America, each has broadly differentiated characters on which to base specific rank.

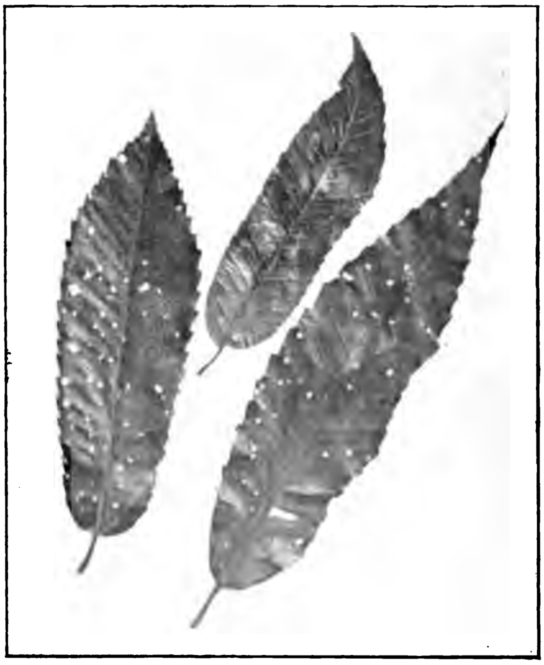

Fig. 1. Types of Chestnut Foliage. (1) European at Left; (2) Japanese in Center; (3) American at Right. Note relative form, serrations, freedom of the Japanese only from leaf blight.

European Group

The European chestnut is a large, close-headed, but broadly spreading tree, with thick branches and large buds; oblong-lanceolate and generally abruptly-pointed, thick, leathery leaves, bearing small, sometimes incurved teeth, and generally pubescent beneath when young, and smooth and green on both sides when mature. The burs are enormously large, with a thick, felt-like, hairy lining; the nuts are thickly pubescent at the tip, and sometimes over considerable of the sides; variable in quality from bitter to sweet; with a long point. The trees retain the foliage late in the fall, and it is susceptible to the attacks of leaf fungi. (See Fig. 1.)

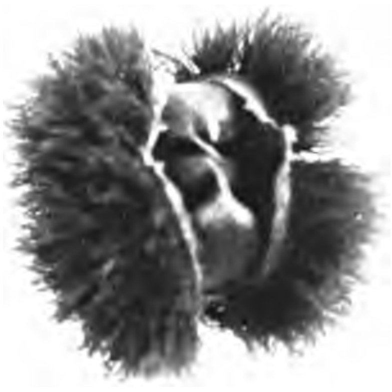

Fig. 2. Alpha Japanese. Chestnut Grown in Clarke county, Washington. —*Maxted Photo.*

American Group

The American chestnut differs in a larger, freer, more upright form; more slender branches; larger, thinner, more pointed leaves, with larger, more spreading teeth, in a greater pubescence when young; smaller burs, and sweeter, smaller, more pubescent nuts. The foliage is also susceptible to leaf fungi, and is shed earlier in the fall. (See Fig. 1, 2.)

Japanese Group

The Japanese chestnut is a semi-dwarf, close-headed tree, with very slender, slow-growing wood, bearing small buds close together, and apparently, though not actually, opposite, on the smaller growth. The leaves are smaller than the American or European, quite like the peach-leaf in appearance, long, narrow, generally pointed, with narrow, truncate or cordate base, white tomentose beneath and pale or bright green above, teeth, small and sharply awn-pointed. The burs are comparatively small, with a thin, often parchment-like, hairy lining. The nuts large, comparatively free from pubescence, earlier to ripen, and poorer in quality, though excellent when cooked. The foliage of the Japanese is apparently free from the attacks of the common leaf fungi. The tree is a beautiful specimen for ornamental purposes. (See Fig. 1.)

The Blossoms

The chestnut is monecious, that is, the male and female flowers are separate on the same tree. Young, vigorous-growing trees frequently produce male flowers only, and after their excessive vegetative vigor ceases and the trees become older, the female flowers develop. The staminate flowers are borne in long, slender catkins, and are much more numerous than the pistillate flowers. The pistillate flowers are clustered at the base of a long catkin, on the distal end of which the staminate flowers open later in the season, the catkin aborting down to the little female blossoms.

The pistillate flowers are probably fertilized by both sets of staminate blossoms, the early ones fertilizing the early opening blossoms, and the later ones furnishing the pollen for those that are retarded. Thomas Meehan tells me that he thinks the pollen from the late staminate blossoms performs the function of fertilization, and that the great show of staminate catkins is a waste of energy, in the American chestnut. In both European and Japanese varieties, I have noticed that most of the pistils are receptive while the early staminate flowers are in bloom.

Suggestive Hints on Chestnut Culture

The Production of Varieties

Seedlings. The large varieties of cultivated, foreign chestnuts have been evolved from the wild types through centuries of selecting slightly better seedlings in each successive generation. Chestnut seedlings exhibit variations from the smallest American nuts to the largest Japanese, from enormous productiveness to approximate sterility, from an acorn-like flavor to a sweet, desirable quality, from ripening in August to maturity in October. Some of the seedlings hold their dead leaves all winter, others have nuts enclosed in a bur from which it is difficult to extract them. Certain varieties, like the *Parry*, are extremely prepotent, and their progeny exhibit striking similarities. From the desirable variations new kinds can be produced.

Crosses

New kinds may be produced by crossing the varieties within the species, or the Japanese, European, and American varieties may be intercrossed. Mr. Luther Burbank informs me that he has a few hundred hybrid chestnuts just beginning to bear—crosses of Japanese, European, Chinese, chinquapin, and others, among which are a number of extremely valuable varieties. Mr. Burbank thinks that *all* the chestnuts intercross as readily as the various varieties of apples.

Bud Varieties

New varieties may possibly be developed from bud variations, as tree under apparently similar conditions, show the widest differences in bearing tendencies. The variations might be perpetuated in newly grafted trees, though it is quite possible that the violent differences within the cultivated varieties are due to the reciprocal action of stock and scion, when the union is imperfect. At any rate, in the perpetuation of a variety, too much care cannot be used in selecting scions for propagation only from trees with desirable bearing tendencies.

Propagation

Grafting. Chestnuts are propagated usually by grafting, though budding, with buds that have been held dormant, is frequently practiced in the spring in the South. The scions are inserted upon the stocks by different propagators in four positions, *i. e.*, in the root, in the crown, in the body or stem, and in the top or branches of the tree. Two methods of grafting are generally employed, the cleft graft for stocks of large size, and the whip-graft for smaller stocks. A third system, the bark graft, is occasionally used for very large stocks. The grafting technique must be performed most skillfully to insure a successful outcome. The scions should be cut with precission, and the young, fine wood, especially in the Japanese varieties, should be discarded. Immediately after inserting the scions, the stubs must be carefully covered with wax, or with waxed cloth, the latter method being preferable for young trees, as the stubs often do not close tightly. If the stub can be cut two or three inches above a fork, the openings close more firmly.

Britton, of the Connecticut station, in 1898, found from grafting over two hundred scions of the Japanese and European varieties on American stocks, that more scions live when inserted after the leaves had begun to expand.

He says that the early grafts that survived made a much larger growth than the later ones. He states also that the scions take more readily in young shoots.

Stocks for Grafting in the Nursery

The cultivated varieties of the European chestnut are generally propagated, either upon their own American-grown seedlings, or upon native, American seedlings. Japanese varieties are often propagated upon seedlings grown from imported Japanese seed. Occasionally, seedling trees of the European chestnut are imported, but they are worthless for propagating purposes as the bodies become afflicted with sun scald.

Each species seems to work best upon stocks of the same type, but there is a close affinity between the Japanese and the American stocks, and between some varieties of the Europeans and the American seedlings.

The European varieties are propagated largely upon American stocks, and successfully with many varieties, but nurserymen are coming to use seedlings of the European varieties in preference. The European scions sometimes outgrow the American stubs, making an enlarged, or a poorly united union, the scion frequently blowing out during the first season of growth.

The Chestnut Orchard

The chestnut orchard should be located on a well drained, porous soil, with a deep, porous subsoil, through which the roots can descend and supply the tree with moisture in drying weather. It is more important to have thoroughly drained soil than soil of a particular character, and the trees will then flourish on light sands or heavy clays. Limestone lands are generally uncongenial to the chestnut, due probably to the close proximity of the underlying rocks to the surface, for in limestone soils with well-drained, deep, porous subsoils, the chestnut thrives heartily.

The European chestnut should be set not less than forty feet, and the Japanese not less than thirty feet apart each way. The trees can be planted much closer at first and cut out to those permanent distances ten or fifteen years later after several profitable crops have been removed. The care of the young orchard should be the same as that given a young apple plantation.

Subsequent Care of the Trees

Grafted chestnut trees are precocious. The grafts of the Japanese sorts on sprout land frequently set fruit the same year of insertion, and their early bearing tendencies often prevent a satisfactory development of the tree. Two-year-old grafts are commonly loaded with burs in both Japanese and European kinds, though the Japanese varieties as a class bear earlier, both when grafted and from seed. It would probably be a profitable undertaking to keep the burs picked from the young trees for three or four years, in order that they might become strong and thoroughly established before the strain of reproduction is upon them. The young trees should also be pruned to an open spreading form, with three to five main branches on which the top will eventually form, after which the trees themselves will need little care other than good culture. If the trees are allowed to over-bear, the nuts run down in size.

Do Varieties Need Cross Fertilizing

The question cannot be answered satisfactorily with our present knowledge. Nearly all of the European varieties abort a large proportion of their burs when the latter are partly grown, the Paragon and Comfort being freer from it than any of the other kinds. I have seen instances of European trees that are non-productive at ten years old when standing alone, but whether they would be more productive in proximity to other varieties is an open question. The Japanese varieties do not abort their burs, and seem to be completely self-fertile. In the absence of definite information, we would advise mixed planting as a safeguard.

Prices of Nuts

During the years 1896 to 1898 prices of various varieties of chestnuts sold all the way from $4.00 to $14.00 per bushel.

The earliest and the biggest chestnut commands the highest price. Earliness is the more important factor. Quality, at present, is not considered by the purchaser, the crop selling largely from the street stands to boys and girls. The nuts should be carefully graded into two or three sizes before shipping and the wormy ones destroyed, as the price of a mixed lot is regulated by the smallest nuts. The chestnuts are shipped in bags, or in crates holding a number of small baskets. The burs and nuts are gathered every few days, and the burs that do not cast their nuts are torn open by an operator wearing leather mittens.

European or Japanese Varieties

One of the first considerations to confront the prospective commercial chestnut grower is, "Shall the European or the Japanese varieties be planted, or both?" The question is a difficult one to discuss without awakening enmity, for both species have equally earnest advocates. The writer, however, will at-

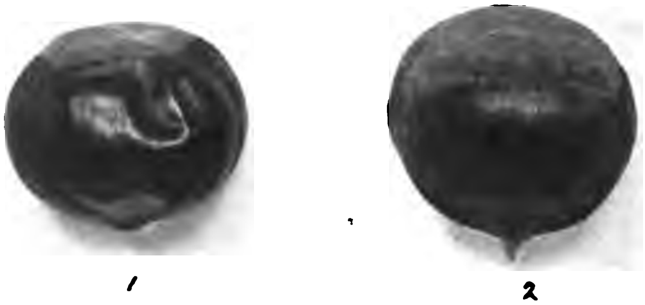

Fig. 3. French (1), and Japanese (2), Chestnuts Grown by Mr. A. A. Quarnberg at Vancouver, Washington.

tempt to place their merits side by side as impartially as possible, basing the estimate not on a limited observation of a few trees, but on an acquaintance with both species growing together on a large commercial scale.

Japanese Group

Advantages

1. Early maturity of tree.
2. Ease of caring for trees.
3. Early ripening of nuts.
4. Large size of nuts.
5. Enormous productiveness.
6. Small size of bur.
7. Freedom from leaf blight.
8. Freer from worms than Europeans.
9. The money makers in the large groves.
10. Affinity for American stocks.
11. Ornamental value.

Disadvantages

1. Overbearing, if not thinned.
2. Poorer quality of many.
3. Delicate growth of some.

European Group

Advantages

1. Great productiveness of some.
2. Timber value of tree.
3. Finer quality.
4. Beautiful appearance of nuts of some.
5. Prolific bearing of a few.

Disadvantages

1. Late maturity of many.
2. Late ripening of nuts.
3. Shy bearing of many when young.
4. Largeness of bur, which may become watersoaked and break the trees.
5. Great susceptibility to leaf blight.
6. Greater susceptibiltiy to weevil.
7. Do not compare with Japanese in the commercial groves as money makers.

It can be stated as a general principle, that the Japanese flora is better fitted to the climatic conditions of the Eastern United States than the flora of Western Europe, the latter succeeding best on the Pacific coast. Hence it is thought that if the Japanese species is used as a basis for further improvement, happier results will eventually follow its amelioration in the Eastern United States. The Japanese or European varieties, as they exist, should be looked upon only as stepping-stones to better kinds. By the continued judicious selection of seedlings from varieties of the best flavor, the quality of the Japanese chestnut can be greatly improved in a few generations. Some of the finer quality of the chinquapin or of the native chestnut might be infused into the Japanese with happy results, and a more vigorous tree would follow the incorporation of a little European blood. One type should supplement the other wherever the adaptability of both is proven.

Estimate of Varieties

The varieties of the cultivated chestnuts are not well enough established, nor have they been grown on a sufficiently comprehensive scale to determine their horticultural value. Some of the most promising kinds are confined to a few trees only. It is therefore impossible, to compare the various kinds, justly, but the reader would probably not be satisfied unless some expression of preference was recorded. Nothing more than a personal preference can be expressed, and the following varieties include those that the writer would plant on his own place for commercial purposes. The first list is based upon the behavior of the varieties that are growing on an extensive scale, the second list includes those kinds which are promising, but which have not been grown extensively.

Varieties Grown Extensively

Japanese—Alpha, Reliance, Parry. First choice.

European — Paragon. First choice. Numbo. Second choice.

Varieties Not in Large Blocks, but Promising

Japanese—Kerr, Kent, Killen. First choice. Biddle, Felton, Martin. Second choice.

European—Ridgely, Scott, Styer. First choice. Dager, Darlington. Second choice.

The Hale, McFarland, and Coe are highly spoken of, but the writer has never seen specimens and is therefore unable to give them a fair estimate.

G. Harold Powell,

Delaware College Agricultural Experiment Station, Newark, Delaware.

CHESTNUT DISEASES

Anthracnose

Marsonia ochroleuca B. & C.

Is a disfiguring spotting of chestnut leaves. Small, dead areas with characteristic borders are produced by this fungus. Such applications of fungicides as are made for shot hole fungus of the plum and leaf spot of the horse chestnut, will be found useful when treatment becomes necessary on the chestnut.

(Japanese varieties are immune to this trouble.—Ed.)

A. D. Selby,

Wooster, Ohio.

Body Blight

The trunks of the chestnut trees in the nursery frequently blight upon the south and west sides. The bark splits or sinks in and the affected tree finally dies. Larger Japanese seedling trees, eight to ten years old, are sometimes affected in the same manner, but I have not observed the difficulty on the larger Europeans. Imported European seedling trees seem to be more susceptible than any others, and American seedling stocks are affected to a lesser extent. Fig. 1 shows sections of the trunk affected with the body blight. The sections were taken from trees in a lot of one thousand imported European seedlings, nine hundred and fifty of which died soon after setting out. As the malady nearly always appears on the south and west sides

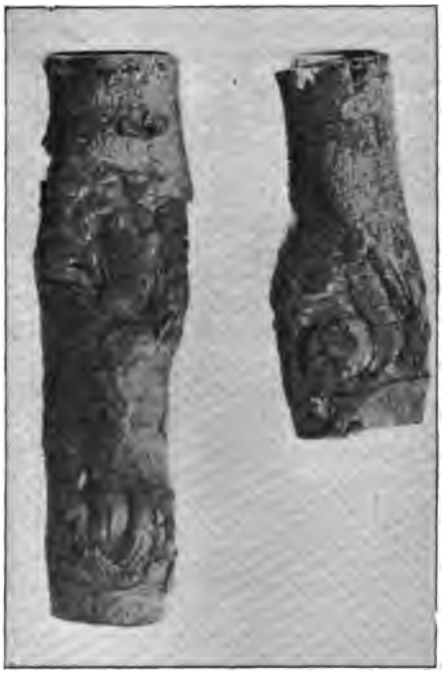

Fig. 1. Sun Scald or Body Blight.

of the tree, it is thought that the trouble is not unlike the *Sun Scald* of cherry and other young fruit trees.

G. Harold Powell

Delaware Bulletin 42.

Canker. See *Bark Disease*, this section.

Chestnut Bark Disease

Diaporthe parasitica Murrill

This disease occurs in the northeastern part of the United States and threatens great damage to chestnut trees of all species except certain Japanese varieties which seem to be immune. The flavor of these seems to be inferior to that of the improved European sorts but is believed that varieties can be developed by crossing which will combine the flavor of the European and the resistant qualities of the Japanese varieties.

The disease girdles the twigs and affected limbs and otherwise reduces the vitality of the tree. The fungus confines itself to the bark and cambium and seems to gain entrance almost wholly through wounds.

No satisfactory method of control has been discovered except that of severe cutting when the disease first appears on branches and twigs.

References

1908. Metcalf, Haven. Immunity of the Japanese Chestnut to Bark Disease. Bureau of Plant Industry Bulletin 121.

1909. Duggar, B. M. Fungus Diseases of Plants, Ginn & Co., N. Y.

Chestnut Blight. See *Chestnut Bark Disease*, this section.

Crown Gall. See under *Apple Diseases.*

CHESTNUT PESTS

Chestnut Weevils

According to Chittenden* there are two species of chestnut weevil, the "larger" and the "lesser."

They have extremely long, slender beaks or snouts, nearly as fine as a horsehair, and considerably longer than the body in the female. By means of this long beak the female is able to penetrate the thickest bur of the chestnut with its long spines and to cut out, with the minute and sharp mandibles at the tip of her beak, a little hole for the deposition of her eggs. These are inserted through the husk into the growing nut.

The two species resemble each other greatly in color and in markings, the general color of both being golden yellow, ochraceous, or clay yellow, frequently tinged with olive, and a little paler on the lower surface. The disk of the thorax is a little darker with a wide bright band on each side, and the elytra, or wing covers, are mottled with rich light brown or dark brown markings of variable size and extent.

Larger Chestnut Weevil

Balaninus proboscideus Fab.

The larger chestnut weevil is considerably the larger and more robust species. The female rostrum or beak, although proportionately of about the same length as in the lesser weevil, is perceptibly more prominent because less curved, the curvature being toward the tip. It is also more widened at the base. The body measures from one-third to nearly one-half of an inch in length, and the beak of the female is often five-eighths of an inch long.

The larvae is milk-white, robust, fully three times as long as wide. The fully developed larva in ordinary resting position measures nearly half an inch. Although the larvae has no true legs, it is able to crawl, slowly and clumsily, it is true, by means of the flattened lower surface, locomotion being aided by transverse wrinkles.

The pupa is of a clearer whitish color than the larva, and shows the principal external organs of the body of the future beetle, all, except the beak, folded tightly to the body.

This species, like the other weevils under consideration, is native to America and is known from Rhode Island to Virginia, the District of Columbia, southern Ohio, and Tennessee, and westward to Kansas. The geographical distribution of this and the other nut weevils has as yet not been carefully studied, but in all probability it is considerably more extensive than above stated.

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* Bureau of Entomology Circular No. 99.

Lesser Chestnut Weevil

Balaninus rectus Say.

The lesser chestnut weevil has the scape of the antenna longer than in the preceding species and the first joint longer than the second. The average length of the body is about one-fourth of an inch, but the size varies, as in all of these insects.

The distribution of this species extends from Canada and Massachusetts to North Carolina, Tennessee, and Ohio, and probably farther westward.

The larvae is only a third of an inch long and its length is about three times its width. The body is milk-white and the head light brownish yellow.

Life History of Both Species

The life history is similar for both species. These, as well as related nut and acorn weevils, hibernate in the larval condition and in the soil. Both make their appearance with the first blooming of chestnuts. The beetles increase in number as the nuts approach maturity, or until about the middle of September or a little time before the nuts are first marketed. Then they may be seen in greater abundance, several pairs, frequently of both species, often occurring on a single bunch of burs. From examination of many burs it is deduced that the first eggs deposited are laid (seldom and very sparingly) in the soft, woolly material surrounding the forming nut; but later they are inserted in the kernel just under the inner skin, and occasionally they are deposited somewhat more deeply. In no case has the egg been found in the outer husk.

Eggs are laid singly, but many are placed in a single nut, as high as 40 or more (of the smaller weevil) in imported nuts, and as many as 9 in native nuts.

By the end of September or the first week of October the beetles disappear. At about the same time, when the nuts first fall, the larvae begin to mature and issue from round orifices which they gnaw through the shell.

On leaving the nuts they burrow into the earth to depths varying from 2 to about 8 inches, according to the hardness of the soil. The larval period probably lasts from three to five weeks in the nuts, and about ten months in the earth.

The beetles do not fly readily, but cling tightly to their resting place or drop when disturbed; yet, as their bodies are not heavy and their wings strong, they are obviously able to cover considerable distances especialy with the wind. Ordinarily, however, they are sluggish, like most other weevils, and probably do not go far from the vicinity of the trees which have sheltered them as larvae, although they undoubtedly migrate when food is scarce.

Natural Enemies

A natural enemy of the nut weevils is known, a small four-winged wasplike fly, the braconid parasite *Urosigalphus armatus* Ashm., which develops in the body of the larva.

Methods of Control

The most practical remedy for nut weevils that can be suggested is the early destruction of the "worms" in the nuts by means of bisulphid of carbon and the observance of clean orchard management and other cultural methods.

The Water Test of Infestation

Having doubts of the efficacy of this old-fashioned test of the difference between "wormy" and healthy nuts, an experiment was made by the writer with native chestnuts obtained from a street vender. To begin, 40 per cent were obviously "wormy," and only 60 per cent apparently sound.

Results of Water Tests with Native Chestnuts

NUTS WHICH ROSE TO SURFACE

	Per Cent
Uninfested	10
Showing minute marks only; good flavor; salable	20
Containing full-grown grubs	10
Containing immature grubs	60

NUTS WHICH REMAINED ON BOTTOM

	Per Cent
In perfect condition	40
Slightly injured	30
Badly infested	20
Completely filled with grubs	10

As will be seen from this experiment, noticeably wormy nuts, as evidenced by loss of weight, and the exit holes of the "worms," naturally rise when placed in water, but the remaining nuts may or may not be infested, and hence require further test than whether they will sink or float.

Direct Remedies

Bisulphid of Carbon

The value of bisulphid of carbon as a fumigant for chestnuts infested by weevils is now fully established. The dead weevil larvae are at this time so small that the average person would never detect their presence, while if they were permitted to develop they would soon destroy the nut for food.

The following treatment is recommended: ½ ounce of bisulphid of carbon to one bushel of nuts placed in a kerosene barrel of 50 gallons capacity, tightly covered and left for two days.

Scalding and Drying

Some growers make a practice of plunging the nuts as gathered into boiling water just long enough to kill the contained insects and yet not injure the nuts for sale, after which they are dried before being marketed. This may be profitably accomplished by using a large sieve, which is filled with nuts, dipped in the water, and removed in about five minutes. Salt water, it is claimed, is preferable for scalding, the brine serving to keep the shell soft and pliable and rendering the kernels more palatable than when not thus treated.

Nuts for planting should not be scalded, and care should be taken not to cook the kernels of nuts intended for sale.

Heat

Infested nuts can be subjected to a temperature of between 125 degrees Fahrenheit and 150 degrees Fahrenheit without injuring them for food or for seed. and this will effect the destruction of the larvae within. Some growers of chestnuts destroy the weevils by kiln-drying.

Cold storage has been employed and this is successful in arresting the development of the larvae, but nuts thus treated were deficient in flavor.

Preventives

Choice of Location for the Orchard

It is most undesirable to plant in the immediate vicinity of woodland abounding in wild chestnut and chinquapin, since these trees furnish natural breeding places for the insects, and are, therefore, a constant menace to successful chestnut culture.

Wild chestnuts or chinquapins in the immediate vicinity of cultivated groves should be gathered. To secure good results, it is imperative to plant or graft trees on smooth ground, first for the sake of economy, and second to permit the collection of all of the nuts, leaving none for the propagation of weevils.

Two-Lined Chestnut Borer

Agrilus bilineatus Weber

Occasional outbreaks of this insect have been reported when they have done considerable damage.

The beetle is elongate, black with a more or less greenish tinge, about three-eighths of an inch long.

The larva works just under the bark of the tree making galleries which results in a practical girdling.

The most important requisite in controlling the borer is clean culture. All dead wood should be cut out and burned. Cut and sawed timber should have the bark removed.

For shade trees some mechanical protection during the egg-laying season is practicable.

Sprays of lime and Paris green are deterrents, also fish oil and petroleum preparations.

Reference

Bureau of Entomology Circular No. 24, Revised.

Cider Products Made on the Farm

There are but few orchardists whose apples are of so uniformly good quality that there is not quite a percentage that will have to be disposed of in some way other than shipping to market. One of the best ways of disposing of this fruit is the making of it into vinegar. The

New York Experiment Station recommends the following as one of the most satisfactory methods of making vinegar:

When cider is pressed from the apples the barrels should be filled about two-thirds full and the bung replaced by a loose plug of cotton, which will lessen evaporation and keep out bugs and dirt. When the quantity of vinegar to be made is considerable the barrels should be placed in a room where the temperature can be kept at from 70 degrees to 80 degrees during the fall and early winter months. If the batch is small the barrels may be left out of doors while the weather is warm and then placed in the warmest room convenient and later in a dry cellar. If the temperature of the storeroom does not fall below 45 degrees the conversion of the sugar into alcohol will require about six months, but the process of fermentation may be hastened by the addition of fresh commercial yeast. When the cider quits working the clear portion should be drawn off, the barrel rinsed out and the liquid replaced, with the addition of from two to four quarts of good vinegar containing some mother.

The next process, the change of the alcohol into acetic acid, may be effected in three months, and may require two years. In any event, it will take place most rapidly in a temperature ranging from 65 degrees to 75 degrees.

When the vinegar has reached the per cent of acetic acid, the barrels should be filled full and tightly corked. This will prevent other changes and will cause the vinegar to keep its strength.

Cider Apple Butter

Takes about one gallon of apples, peeled, cored and quartered, for three gallons of cider. But apples differ. When using sweet russets for thickening, it only takes about eight gallons of apples to thirty of cider. In hot weather, cider should be boiled down to one-third, the same day it is made, then left in stone jars until morning. In cool weather it may be left in barrel in shade until next day. Run cider out of barrel and strain through a poke made of towel. Boil in copper kettle, freshly scoured with salt and vinegar. Kettle must not stand after being scoured, but fire and cider must be all ready for it. Cider must not stand in kettle without boiling, or it will have a bitter taste and be poisonous. Put apples all in cider at once, after it is boiled down, but save out some cider to fill in with and to keep it from boiling over. Apples will rise in kettle as they boil to cook, but will soon go down again. It will take about four hours' constant cooking and stirring to make it so it will keep throughout the next summer. When done dip out into stone jars. Next day heat jars in oven of cook stove, tie up and put away. Skim cider while boiling.

Never allow a chunk or stick to touch kettle, or your butter will scorch. Turn kettles upside down on grass. Clean next morning while grass is wet. If you do not make your butter so thick, put it in jars with stone lids and seal same as fruit. If cider stands all night after it is boiled, let it get hot before putting in apples, and scour kettle before beginning again.

Apple Butter

Take eight gallons of cider, boil two hours, add ten gallons of ground apples, cook until done in a brass kettle, and add 16 pounds of sugar, either soft white or granulated. When done the apple butter may be flavored by adding cinnamon. This amount makes eight gallons of apple butter.

Tomato Butter

To two gallons of cooked apples and two gallons of tomatoes, cooked and pressed through colander, four sliced lemons, add sugar until as sweet as desired, flavor with cinnamon, cook until it thickens and then can.

Peach Butter

Pare, stone and cook peaches until tender, then press through colander. Measure out as much sugar as peaches, after they are cooked. Add one-half of the sugar and cook one-half hour, then add the rest of the sugar and cook from one hour to one and one-half hours, or until thick; then can.

Pear Butter

Pare, core and quarter pears, cook until tender, then press them through a colander, add three-fourths of a pound of sugar to every pound of pears, cook until thick; then can.

Grape Butter

Pare, core and quarter as many apples as you have grapes, cook until tender, press through colander, cook grapes a few minutes, run through sieve. To four quarts of grapes add three quarts of apples and four pounds of sugar. Cook until thick; then seal.

Plum Butter

Cook plums until tender, press through colander, make the butter same as peach butter.

In making pear, peach and plum butter and in preparing apples for grape butter, enough water should be added in cooking them to cover.

Lemon Butter

Two cupfuls of sugar, juice of two lemons, two eggs, one lump butter size of an egg; mix all together and cook in double boiler, stirring all the time until it thickens. This is excellent for breakfast with hot biscuits and butter.

Use Ripe Fruit

The first requirement for good vinegar is to have the ripe fruit. Good apples under hydraulic pressure will give about four and one-half gallons of cider to the bushel. Pears under the same pressure will give more. Every utensil used in the work should be strictly free from must or mold. Hence they should be scalded in very hot water to destroy all germs. After having secured the cider it must be exposed at all times to the air, and the depth of the liquid should be no greater than the surface measure of the vessel holding it. A barrel should not be more than half full during fermentation.

The temperature should be even and rather warm. Temperature determines the time in which the fermentation is accomplished. Eighty degrees gives quickest results; with this heat good vinegar can be had for use in [illegible] months, in which time it should show 6 per cent acetic acid. The ordinary time is six months, with only ordinary temperature. By close attention to these particulars a good healthful vinegar can be cheaply made, which will command from 14 to 20 cents per gallon in the market.

Well ripened fruit should be used, as it contains the greatest amount of sugar which aids in yielding the highest per cent of acetic acid. Under no circumstances use decayed fruit for healthful vinegar. A small yeast cake dissolved in some of the cider and then poured in the barrel will set fermentation going at once. Do not stop the fermentation but let it complete its work. When fermentation ceases, procure some mother of vinegar and put in barrel. If this cannot be had, get some pure sharp vinegar and pour this in the barrel. When completed fill barrel full and cork securely to prevent any undesirable ferments afterwards.

Pear Vinegar

Pear vinegar requires some longer time than apple cider, and will show 8 per cent acetic acid, making it sufficiently strong to be afterward diluted one-half. Vinegar can be made from the small fruits, especially the blackberry, but it is more expensive and the color is not favorable.

Fruit Butter

For fruit butter the cider or juices and the filling should be boiled in separate vessels, to hasten the work and give better appearance to the product. Any sweetening used should not be added until the butters are about ready for removal from the fire. Fruit for the filling should be quite ripe, and it then has all its flavors and is more readily cooked. After the juices are sufficiently boiled down the filling may be added and the boiling continued till it presents appearances of being sufficiently thick, when the sugar may be added such as the nature of the fruit requires. By withholding the sugars till at this state, you prevent danger of scorching, have a better color to the butters and a better retention of the fruit flavors than can be had by adding the sugar at once.

Care must be used to prevent any settling of the filling while boiling, for this will result in scorched butters. Never use spices of any kind for flavoring, as these destroy the natural flavors of the fruits used and cause the butters to become strong in time; also, they give the butter a dark, uninviting appearance.

Juices of one kind of fruit used with filling of another make a very inviting butter. As for instance, pear cider with apples for thickening, or any combination one may like. After butters are cold, if one adds to the surface a few spoonfuls of brandy it will prevent any mold from forming at all. Kept in a cool, dry room, butters thus made will grow better with age.

Other Recipes

To make apple butter, take a half barrel of good, fresh cider and boil down one-half, then add three bushels of good cooking apples that have been pared and quartered. We have made small quantities at a time in a porcelain kettle on the kitchen stove, but if one can procure a large copper kettle, it is best to make it out of doors, using the long handled stirrer. When the apples begin to cook up, the mixture should be constantly stirred until done, when it should be smooth and thick. Just before taking off add ten pounds of sugar. If sweet apples are used for both cider and filling, the sugar may be omitted. If the apples are not of good cooking kind, they can be ground up in a meat grinder, which will hasten the cooking process. If this apple butter is cooked quite thick, it will keep without sealing.

Very nice peach butter can be made by boiling down the cider the same as for apple butter and filling in with peaches. Pear butter is made the same way, using ripe pears for filling.

To make grape butter, put grapes on to cook, with water enough to cover, boil an hour or more, pour while hot over a sieve. Measure the juice that drains through and put on stove to boil again. Press the remainder of grapes through sieve to remove skins and seeds. After the juice has boiled down one-half, add half as much sugar as the measured juice, and add the pulp that has been pressed through the sieve or colander. It will need to be stirred only a short time. This is to be sealed in either glass cans or stone jars.

Tomato butter is made in the same way as grape butter, except that the juice should be boiled until nearly thick before adding the tomato pulp.

A butter made of equal parts of plums and pears is superior to that made of either fruit alone.

Cook each fruit in water separately, then put plums through a sieve and add the pears. Use sugar to make sweet enough after the mixture has boiled thick and smooth.

Citrange

The citrange, which is a cross between the worthless Trifoliate orange of Japan and our ordinary sweet orange, is not an orange, but a hardy substitute for the lemon. The fruits are very juicy, containing a larger amount of juice proportionately than the best lemons. They make a refreshing "citrangeade," similar to lemonade, which people who have made a comparison pronounce equal to or even better than the latter. The fruits also make excellent pies and marmalade, and for these purposes are probably equal to the orange and the lemon. The citrange will undoubtedly prove valuable for general culinary purposes in the making and flavoring of cakes, making jellies and preserves, and in many other ways in which the lemon is now employed. When it is considered that these citranges can be grown throughout a large part of New Mexico, Utah, Nevada, Oregon, and Washington, where there is now a dearth of acid fruits their great value becomes evident.

There is at present, however, no market for the citrange, and it will probably prove of value mainly as a home fruit for cultivation throughout the regions mentioned, where the sweet orange, the lemon, and the lime can not be grown. The trees are attractive in shape and semi-evergreen, so that they will make desirable lawn trees. Wherever a home can be supplied with them it will be possible on the warm days between the 1st of September and the 1st of December to pick a few fruits and make a desirable and refreshing beverage.

Through the senators of the Pacific coast states, arrangements have been made with a few leading fruit growers to give trees of this variety a trial test. A number of young trees have been distributed by the Plant Bureau, U. S. Department of Agriculture for the purpose.

Citrons

There are two species of citron. One is the species *Citrus Medica* of the same genus as the orange, lime and shaddock or pomelo. The tree is an evergreen shrub growing to a height of about 10 feet; has irregular straggling spiny branches, large pale green broadly oblong, protuberant at the tips and from five to six inches long, with a rough adherent rind, the inner portion of which is thick, white and fleshy, the outer, thin, greenish yellow and very fragrant. The pulp is sub-acid, edible, much less acid than the lemon and the seeds bitter. There are many varieties of the fruit, some of them of great weight and size. The Madras citron has the form of an oblate sphere; and in the "fingered citron," of China the lobes are separated into finger-like divisions formed by separation of the constituent carpels, as occurs sometimes in the orange.

The citron tree thrives in the open air in China, Persia, West Indies, Madeira, Sicily, Corsica, in the warmer parts of Spain and Italy and the American continent.

The rind of this species of citron yields two perfumes, the *oil of cedra*, and the *oil of citron*, with the ultimate composition of an isomeric with the oil of turpentine. When candied, it is much esteemed in dessert and in confectionery.

The other species of citron is a variety of watermelon, nearly solid, almost flavorless, growing on a vine that resembles the watermelon vine, the fruit of which is made into preserves, resembling the real citron.

For CULTURE. See *Watermelon.*

The first species named is not grown largely in the United States, but is grown with some degree of success and recommended by American Pomological Society as follows, for kitchen purposes:

Lemon, Lyman and Orange in Florida and the southern portions of the Gulf States.

For DISEASES AND PESTS OF CITRON OF THE TREE VARIETY, see under *Lemon and Orange.*

For the VINE CITRON, see under *Watermelon and other cucurbitous crops*, as; *Cucumber*, *Cantaloup*, *Squash*, *etc.*

Citrus Fruits

This subject is treated under the respective fruits, as follows:

Citrons, Kumquats, Lemons, Limes, Oranges, Pomelos or Grape Fruit, Tangerines.

Citrus Fruits—Trees, Production and Value
1910 Census

	—1910—		—1909—		1899
State—	Trees of bearing age	Trees not of bearing age	Production (boxes)	Value	Production (boxes)
All citrus fruits *..	11,486,768	5,400,402	†23,502,122	$22,711,448	7,098,486
Oranges, total	9,737,927	4,327,271	19,487,481	17,566,464	6,167,891
Arizona	33,373	56,982	32,247	52,341	11,116
California	6,615,805	2,093,410	14,436,180	12,951,505	5,882,193
Florida	2,766,618	1,097,896	4,852,967	4,304,987	273,295
Louisiana	266,116	155,016	149,979	222,339	1,285
Mississippi	10,452	38,637	3,779	8,648	......
Texas	42,384	867,407	10,694	22,090	......
Lemons, total	956,920	396,111	2,770,313	2,993,738	876,876
California	941,293	879,676	2,756,221	2,976,571	874,305
Florida	11,740	7,329	12,367	13,758	2,359
Pomeloes (grape fruit), total	710,040	640,597	1,189,250	2,060,610	30,790
California	43,424	25,589	122,515	148,180	17,851
Florida	656,213	600,049	1,061,537	1,907,816	12,306
Limes, total	45,387	30,239	11,318	12,478	22,839
Florida	45,369	30,088	11,302	12,457	22,714
Tangerines, total	27,271	8,873	38,752	68,770	(‡)
California	3,637	34	3,581	4,188	......
Florida	23,234	8,839	34,871	64,082	......
Mandarins, total	7,227	1,923	3,896	6,553	(‡)
Louisiana	6,875	1,900	3,340	5,945	
Kumquats, total	1,988	358	1,112	2,826	(‡)
Florida	1,955	222	1,091	2,768	......

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* Includes a small number of citron trees in 1910 and the value of their product in 1909, also a small amount of product in 1899.

† Exclusive of a small quantity of citrons.

‡ No report.

Clean Tillage. See *Apple Orchard, Cultivation of.*

Climate. See *Selecting Site for Apple Orchard.*

Climatic Conditions as Affecting Certain Crops

It seems to be a provision of nature that everything cannot be successfully grown everywhere. The wisdom with which we decide upon the adaptability of crops to climatic conditions will determine in a large measure the degree of success resulting from our labor. It would be folly to try to grow oranges for commercial purposes in Colorado, Montana and Washington. It would be equally unwise to try to grow winter apples in the regions best adapted to the orange. In like manner, but not so marked, there are adaptations of fruits to interior and coast climates. For instance, the climate of Puget Sound in the state of Washington, as contrasted with the interior and eastern portions of the same state. On the west side of the Cascade range, irrigation is seldom practiced, while on the east side, there are sections where nothing could be grown without irrigation. On the west side, the rainy season is in autumn, winter and spring, followed by a dry season in which certain kinds of crops suffer for lack of moisture. On the east side, by the process of irrigation, moisture is present wherever the farmer chooses to apply it.

The result is that on the west side all kinds of fruits of the early maturing varieties may be produced. Strawberries, blackberries, raspberries, prunes, early pears, cherries and such like fruits are grown as well on the west side as on the east side, with less labor and cheaper land. Granting, therefore, that on the east side as good berries, prunes and pears, could be grown, it would not seem wise to do so in competition with the west side where they can be produced with less labor. In the irrigated district, it might be found profitable to supply the local markets, but not to ship to the general markets. An exception might be the case of crops which mature earlier in the dry section and so secure the higher prices obtained for the early fruits, as for example, the Kennewick strawberries, which arrive in the market ten days to two weeks before the berries from the coast section. On the other hand, the east side can produce apples and peaches and perhaps other varieties of pears, better than they can be produced on the west side. They have their dry season at a time when the apple needs moisture to make its fullest development.

Second, it needs the bright sunshine to give it color at a period when, on the west side, there is the beginning of the rainy season.

Third, in the humid climate, fruits are more subject to fungus diseases, than in the arid climates. It is not contended by fruit growers on the west side, that they can successfully compete with the east side in the growing of apples, but they do contend that they can compete successfully in strawberries, other small fruits, prunes and pears. Our observation leads us to conclude that their claim is just, except as noted in the case of the earlier markets. I have not seen strawberries as have been grown in the Vashon Island and other Sound districts nor better cherries than those grown in the Willamette valley, Oregon, nor better raspberries and blackberries than grow in the Puyallup valley. As for the growing of pears, I have seen them as well developed, and to all general appearances, as good as those grown on the east side. It would seem, therefore, that the growing of certain fruits, should be localized into those sections where they will produce the most money with the least expenditure of labor.

GRANVILLE LOWTHER

CLOVERS. See *Apple Orchard Cover Crop.*

CLOVER APHIS ON APPLE. See *Aphids.*

DISEASES AND PESTS OF CLOVER AND ALFALFA

Clovers, alfalfa and other similar field crops are treated in this work only in connection with the orchard. A brief section covering some of the principal diseases and insect pests of these crops is here given.—Ed.

DISEASES

Anthracnose

Three anthracnoses occur upon clover; the more common of which is due to the same fungus *(Colletocrichum trifolii* B. & E.) as the anthracnose of alfalfa. These show lesions of the stems and leaf stalks and may be detected in the new seedlings in late summer through the dying of the leaves of these plants. It is not known how serious this may prove upon clover.

The second anthracnose fungus *(Gloeosporium trifolii* Peck.) has been known longer than the first and occasionally shows by killing the tops of large clover stems in meadows. It is apparently not a serious disease, although a very interesting one to study in connection with the anthracnoses due to *Colletotrichum.*

The third anthracnose upon clover *(Colletotrichum cereale* Manns.) is the anthracnose of wheat, rye and oats.

Two new anthracnoses have been discovered attacking alfalfa; the first of these, *Colletotrichum trifolii* B. & E., so far as we know occurring exclusively on plants of this family, the other, *Colletotrichum* sp., occurring only on alfalfa in northern Ohio. The first one, which we may call clover anthracnose, was discovered in Tennessee and has appeared upon alfalfa as well as red clover in the southern portion of Ohio and in Arkansas. It is less prevalent on alfalfa than upon the red clover. Both of these diseases show as a specific lesion or diseased spot on the stem or leaf stalk in the advanced stages of attack. Following this the plants wilt or die and are discovered in this way.

Bacterial Blight (Yellowing)

A bacterial blight of alfalfa, of which the causal organism has not been definitely determined, has been reported from Colorado where it appears to be spreading. In 1907 and to a still greater extent in 1908, there was much complaint of general yellowing of leaves of second crop alfalfa in Ohio and adjoining states, even extending to North Carolina. The symptoms are general yellowing of this crop.

Black Spot

Phyllachora trilfolii (Pers.) Fckl.

Is due to a fungus which attacks the leaves of clover causing dead spots and dark discolorations on the under side of the leaves. As a rule these attacks come so late in the working life of the leaves that the injury is slight.

A. D. SELBY,
Wooster. Ohio.

Crown Gall

Urophlyctis Alfalfae

H. S. JACKSON

This is a comparatively new disease in North America. It was first observed in this country in California in 1909, and has since been found elsewhere only in Arizona and Oregon. This disease was first called to the attention of the writer in May, 1911, when specimens of alfalfa crowns affected with this disease were sent in from Josephine county. Since that time it has been reported from a number of sections in Jackson and Josephine counties. It is probable that the disease occurs also in other localities, but our attention has not, as yet, been called to it.

The disease was first described from Ecuador in 1892 and has since been reported from a number of sections in Europe, notably Germany, Bulgaria and England.

So far as is known, the disease affects only the alfalfa. Experiments carried on in an attempt to grow it on clover and other plants have failed.

Symptoms

The disease is characterized by the formation of galls at the crown of the plant. The galls are more abundantly produced at the base of the stem, but may occur on the upper part of the root. The galls in some cases occur several inches above the ground on the stems. They present a very much roughened exterior and vary in size from that of a pea or smaller up to four or five inches in diameter. In form they are often confluent.

Seriously affected plants are killed. Usually the disease will be found in the field in patches in which many of the plants are dead or in various stages of decline. The diseased plants are of a weak growth; the foliage is yellow and the leaves are reduced in size.

Cause

Crown gall of alfalfa must not be confused with the familiar crown gall of trees, small fruits, etc. It is not the same, and it is unfortunate that there is similarity in the common names. Crown gall on trees and small fruits, as noted in another part of this report, is a bacterial disease.

Crown gall of alfalfa, on the other hand, is caused by a fungus of low order, known technically as *Urophlyctis alfalfae*. This is one of the *Chytridiales*, one of the lowest orders of *Phycomycetes*. In this group the mycelium is sparingly developed. The presence of the fungus in the tissues, however, causes a stimulation which results in an abnormal development of the cells of the alfalfa at the point of attack. On the mycelium, resting sporangia are produced by a simple sexual process. These are found in groups in small cavities in the tissue of the gall. These groups may be observed with the aid of a good hand lens, by making a cut through a fresh gall. The sporangia are liberated by the rotting of the galled tissue and serve to spread the disease. When they germinate they produce a number of small motile spores which cause the infection of new plants.

It is probable that the disease has been introduced into the state through seed. It might be disseminated through alfalfa hay. It is possible that it might be carried some distance by the wind and might be spread locally from one part of a field to another or into new fields by accidental transfer of soil in which resting sporangia are present or in which there are bits of decayed galls. This might occur from driving across a field in which the disease is present and carrying the infectious material in soil on the wagon wheels or hoofs of the horses.

Remedy

No remedy is known. When the disease becomes so serious as to render the field unprofitable, a rotation of at least three years' duration to other than leguminous crops should be practiced. The disease might be prevented from spreading in a field, if the spots are observed soon enough, by a complete destruction of the diseased plants. It might be advisable also to hoe the top soil toward the center and thoroughly spray the ground with copper sulphate or Bordeaux mixture. As a general precaution, it might be well to avoid purchasing seed from localities in which the disease is known to exist. Seed disinfection might perhaps be practical, but this has not been demonstrated. Crown gall is a serious disease, and if it becomes general in the state, is likely to cause great loss. It is hoped that all growers will be on the lookout for the trouble and will use every effort to prevent it from spreading. Little is known of the disease as it occurs under American conditions. A thorough investigation of the trouble would be desirable.

Dodder of Alfalfa and Clover

H. S. JACKSON

Cuscuta sp.

A trouble of alfalfa and clover common in the Northwest and somewhat different in nature from any of the diseases previously discussed, is caused by a parasitic flowering plant known as dodder. The dodders are weeds which, as causing a disease of clover and alfalfa, are known to be common throughout the world, including nearly all sections of the United States where these crops are grown.

Kinds of Dodder

Contrary to the usual idea, dodder in clover and alfalfa is not caused by a single kind or species, but by several different species of dodder which may exist upon these hosts. *Hillman gives five species of dodder which are known to affect alfalfa and clover in the United States. Concerning these he offers the following information:

"Clover dodder *(Cuscuta epithymum*, often referred to as *Cuscuta trifolii)* infests both the true clovers and alfalfa indiscriminately. It is widely distributed in foreign countries and in the United States east of the Mississippi river and in the Northern Pacific states.

"Small-seeded alfalfa dodder *(Cuscuta planiflora)* as it occurs in this country appears to confine its attacks to alfalfa in preference to the true clovers. Thus far there is no evidence of any damage from this dodder to red, alsike, or white clovers. This is by far the most abundant and destructive of the dodders in the Western states.

"Field dodder *(Cuscuta arvensis*, as recognized in the botanies) is widely distributed throughout the United States. It infests both the clovers and alfalfa and also many wild herbaceous plants. It has proved injurious to sugar beets in Utah.

"Large-seeded alfalfa dodder *(Cuscuta indecora)* is common in the West, especially in Utah. It infests alfalfa as well as various wild plants, but it does not appear to damage the true clovers.

"Chilean dodder *(Cuscuta racemosa chileana)* is not generally known in this country. It is common in South America and has been reported from Europe. It is said to have flourished for a time in California many years ago, but subsequently disappeared. It is of interest because of its prevalence in alfalfa and red clover seed-producing regions of South America, from which seed is being sent to the United States, for this dodder infests both alfalfa and red clover. Little is known of this dodder in its relation to forage crops in this country, but since it is being brought here in considerable quantity from South America it is very likely that it will become one of the several injurious species established in the United States."

The three most common ones found in alfalfa seed in the Northwest are *Cuscuta planiflora*, *Cuscuta arvenis* and *Cuscuta indecora*. *Cuscuta arvenis* is common upon clover as well and *Cuscuta epithymum* is also common in this state.

Appearance in Field

Dodder may be recognized at a distance by the yellow appearance of spots in the field. At close range this appearance will be found to be due to the abundance of the yellow thread-like dodder plants which twine about the stems of the alfalfa or clover. At first the dodder will be seen only in a small area, infecting one or two plants. It rapidly spreads in all directions by branching of the threads from these to other plants till large areas are covered. During this spreading, the plant first infested will gradually be killed by the parasite. The dodder dies with it, but continues to grow along the edges of the spot, so that, in the late season, dead spots surrounded by a circle of dodder infested plants may be observed in alfalfa or clover fields. The dodder in the meantime has blossomed profusely and ripened its seed.

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* Hillman. Dodder in Relation to Farm Seeds. U. S. Department of Agriculture, Farmers Bulletin 306, 1907.

Dodder in General

The dodders, or love-vines, are parasitic flowering plants closely related to the morning glories, or bind weeds. There are several species occurring in this state besides those species which attack alfalfa and clover. Most of these grow on weeds, particularly in moist bottom lands, and do no damage to the farmers' crops.

These plants are peculiar in that they are parasitic in habit, depending on the plants upon which they grow for their food, instead of elaborating it for themselves from the soil moisture and air as plants possessing green color are able to do. Dodders are destitute of this green color called chlorophyll and so have not the power of elaborating food for themselves. The plant consists of a yellow stem which is practically leafless. The leaves have been reduced to very small scales. The flowers are minute and are usually produced in clusters on the stem.

Life History

During the first stages of growth the young dodder plant is self supporting, but is wholly dependent on the food stored in the seed. The seed, when it first germinates, consists solely of a yellow thread-like stem. The plantlet may or may not attach itself to the ground. It grows independently until the food in the seed is used up. During this time the thread-like stem has grown sufficiently to grasp and twine about some green plant growing near by. If this green plant is not one upon which the particular species of dodder naturally grows, it dies. If the plant is one for which the dodder has a natural affinity, it twines about the stem and sends suckers or haustoria into the tissue, thus linking the two plants together. The haustoria serve both as holdfasts for the dodder's support and as feeding organs through which the dodder takes the juices of the host, depriving it of needful food which it has manufactured for its own use.

Propagation and Dissemination

Dodder is most commonly distributed by the seed being mixed with the seed of the host plant. The various species of dodder are common in the districts where alfalfa and clover seed are grown and the seed of both host and parasite are matured about the same time, consequently when an infested crop of clover or alfalfa is harvested, the seed is usually found contaminated with a certain percentage of the dodder seed. In this way the disease is disseminated far and wide. The mixed seeds germinate when planted, whereupon the dodder soon attaches itself to the clover and alfalfa, and after becoming permanently established on one plant may be spread from plant to plant in the field, slowly infesting considerable areas.

When dodder is established in the field it may be disseminated by seed to other parts of the field during mowing and raking. The dodder plant may remain alive for several days on the host plant after it has been cut, and if such diseased plants or parts of plants are scattered to other parts of the field the dodder may obtain a foothold on new plants and thus start other spots. It is shown that in New York dodder (*Cuscuta epithymum*) may live over winter on the crowns of infested plants. The seed of the small-seeded dodder which is so common in the West, may be spread by irrigation water.

Preventive Measures

Since dodder is disseminated almost exclusively through the seed, the most obvious method of preventing the introduction of this trouble is by planting clean seed, that is, seed which has no dodder mixed with it. Certain species of dodder infesting alfalfa may be entirely removed by proper screening. The large-seeded species of dodder cannot be entirely removed by any process of screening known at the present time. White and alsike clover, on account of their small size, cannot be entirely freed from dodder. Red clover, by thorough re-cleaning, can be entirely freed of clover and small-seeded alfalfa dodder. The size of the screen is important, but sufficient space is not available here for thorough discussion of the processes of separation.

The most logical precaution to take is never to plant seed infested with dodder. This can be accomplished by buying only the best of re-cleaned seed and having it previously tested by an expert for the presence of dodder.

When dodder becomes introduced into a field, the method of eradication is frequently difficult, depending upon the location of the field and the species of dodder. Space will not permit a detailed discussion here of the methods of eradication, and interested growers should apply for information to the Experiment Station, giving a full statement of conditions, or should procure a copy of the farmers' bulletin above mentioned, in which the methods of eradication are fully discussed.

Downy Mildew

Peronospora trifoliorum D'By.

The downy mildew fungus has occurred in Colorado, and is very liable to occur in other states. No suggestions can yet be made as to its prevention.

A. D. S.

Leaf Spot

Pseudopeziza medicaginis

H. S. Jackson

The common disease of the alfalfa known as leaf spot is prevalent in most sections of the country where alfalfa is grown. It is also the most common fungous disease on this crop in Oregon, but under the ordinary conditions is not responsible for large losses.

Symptoms

The disease is characterized by the formation of brown or black irregular spots on either side of the leaf. The spots are most conspicuous, however, on the upper surfaces. They are small, seldom over one-eighth of an inch in diameter, and are scattered irregularly but frequently very thickly over the surfaces of the leaves.

Cause

In many of the spots the presence of little shining amber-colored structures with black margins may be observed by the aid of a good pocket lens. These are the fruiting bodies of the fungus causing the disease which is known technically as *Pseudopeziza medicaginis.* These structures are the apothecia or fruiting bodies of the fungus and contain, in a layer on the upper surface, many cylindrical sacs, called asci. Eight spores are formed in each of these asci.

The general effect of these spots on the leaves is to cause them gradually to turn yellow and fall, so that the plants, where severely affected, may be almost entirely stripped of foliage. This brings about reduction in forage, and, on account of hindering the normal development of foliage, results in interference with root growth which may cause reduction in subsequent crops.

In Western Oregon the fungus is most abundant in the fruiting condition in the fall, when mature spores are produced in large numbers from September to December. It is possible that the fungus, under Oregon conditions, spreads all winter. It is probable that the fungus is disseminated locally most frequently by the wind, but there is evidence to show that it may be carried to new localities through the seed.

A similar disease, which is considered by some authorities as identical with the alfalfa leaf spot, but which is usually referred to by scientists as *Pseudopeziza trifoliorum*, occurs in Oregon on red clover.

Remedy

On account of the nature of the host crop, no very satisfactory remedy for this trouble suggests itself. When the disease appears to be serious in the spring so that the leaves drop abundantly and the forage value is likely to be much reduced in the first crop, it might be advisable to mow the plants early, as this would cause a tendency to throw out new sprouts which would grow vigorously and might escape the disease. It is also recommended that where it becomes abundant prior to cutting any crop, the plants be mowed a little earlier than usual in order to save loss of foliage.

This disease is seldom serious enough to warrant plowing up a field. Should it ever become so, rotation to other than leguminous crops should be resorted to.

Root Nodules and Root Tubercles Upon Leguminosae

Upon removal of the roots of the clover plant from the soil one finds minute enlargements which are the subject of frequent inquiry. These are nodules or tubercles as they were formerly called, caused by the messmate-living of certain nitrifying organisms, or microbes, with the clover plant. To these microbes in this communal life is due the power of withdrawing nitrogen from the atmosphere and fixing it in the tissues of the clover plants. The same applies in general to the nodules upon plants of this order, the *Papilionaceae*. It thus follows that these nodules are the normal condition of properly nourished leguminous plants of the order *Papilionaceae*, and it likewise follows that the full value of this work of nitrogen fixing is only realized for manurial purposes when the tissues of the clover plants decay in the soil.

Root Rot

Fusarium roseum Lk.—*Gibberella Saubineti* (Mont.) Sacc.

The same parasitic fungus which attacks wheat in the form of scab and also red clover, has been found killing out alfalfa. This fungus may survive in stubble fields where wheat and oats have been grown. It readily kills off the young seedlings of alfalfa and if the soil is not fully prepared for alfalfa seedings, the root-rot may extend its work and further destroy the stand. At present nothing better is known than adequate dressings of lime, preferably raw limestone, for areas to be seeded, together with their proper enrichment. While not specifically noted in America, another root rot fungus somewhat known on other crops (*Rhizoctonia*) has also been reported upon alfalfa from France. Another root rot fungus (*Ozonium omnivorum* Shear) well known upon cotton, also attacks alfalfa in the Southwest.

Rust

Uromyces Trifolii (A. & S.) Wirt

The various sorts of the cultivated clover, red, alsike, mammoth, etc., are attacked by a clover rust. If one will examine the small, dark spots in the clover leaves, he will find a cluster of this reddish fungus beneath. This rust does not spread to other plants than clovers and is commonly regarded as more disfiguring than destructive. It is not nearly so injurious as the leaf spot of alfalfa which is similar in appearance.

Stem Blight

Fusarium roseum Lk.

Stem blight of clover has been found to be due to the same fungus as that of wheat scab. This fungus has been found to cause the death of seedling wheat plants and to follow harvest by attacks on clover stems. It appears at this time to be one of the serious forms of clover sickness. The writer looks upon it as liable to be much more serious even than anthracnose. The only present suggestion for control will apply to control of the wheat scab fungus through recleaning of seed and separation of all scab infected kernels. It is quite likely that clover seedings made in a dry year with little grain scab will not be exposed to the same danger from this blight as those made in wet seasons when the disease is very bad in the grain.

A. D. SELBY

STEM ROT. See *Wilt*, this section.

Wilt or Stem Rot

Sclerotinia trifoliorum

H. S. JACKSON

The disease known as the alfalfa wilt is common. It was first described in Europe but is also recorded in many widely separated sections of this country. It has been reported as serious in New York and California and has recently been found by the writer to be common in Oregon. It was first observed in certain fields in the Willamette valley. It is found to be most abundant and to spread most rapidly during the fall, when the surface of the ground is more or less constantly moist. It seems to be more serious also where there is a heavy stand of alfalfa.

The disease is known to attack clover almost as seriously as alfalfa. It is probable that this disease is one of the causes for the difficulty frequently experienced in obtaining and holding a stand of alfalfa or clover in Western Oregon.

Symptoms

The disease is characterized by a wilt brought about by rot developed on the stems at the surface of the ground or some distance above. The disease frequently kills the plants and on this account large areas may be found in the field where the plants have been entirely killed out. The roots, however, may not always be destroyed, and may later throw out new sprouts. The rotting is invariably accompanied by a white cottony growth of mold over the surface of the stems and leaves and on the ground around the bases of the diseased plants. In this cottony mold are developed, quite abundantly, black irregular shaped bodies of fungus tissue known as sclerotia. In exceptional cases these are as large as a pea. They may also be found inside the stems of plants which have been killed by the disease.

Cause

This fungus is similar to the one which causes lettuce drop and by some authorities is considered identical, though this has not been proved by careful investigation. It seems best for the present to consider it distinct and to use the name *Sclerotinia trifoliorum*. This fungus develops no summer spores. The cottony growth is the mycelium which is also developed inside the tissues. The sclerotia are resting bodies from which there develops stalked fruiting bodies known as apothecia. These are usually described as developing only after a period of rest, commonly in the spring of the year in nature. In Oregon, however, they are found developing in fall, almost immediately after being formed, without any period of rest. Under our conditions the disease seems to spread most abundantly during the fall and winter, though this has not been as thoroughly investigated as would be desirable.

Remedy

No remedy for diseased plants is known. On account of the nature of the host plants, it is probable that no practical remedy will be developed. Where the disease has become serious, rotation should be practiced. The disease seems to be more abundant on heavy soils, especially where the drainage is not rapid, and such soils, if possible, should be avoided.

YELLOWING. See *Bacterial Blight*.

CLOVER AND ALFALFA PESTS

Alfalfa Crane Fly

Tipula simplex Doane (Family Tipulidae)

General Appearance

The adults are long-legged, slender-bodied insects of a light brown color. The females are wingless while the males are winged and somewhat smaller, lighter in color and with longer, frailer legs. The average length of the adult female is about one-half of an inch.

Life History

The small, oval, dark gray eggs are deposited as deeply into the soil as the length of the female's abdomen will allow. They are laid throughout the early spring and summer. These soon hatch into light colored maggots, which begin to feed upon the roots of plants. When full grown they are from three-fourths to nearly an inch in length—the color being a very dark brown. The maggots remain in moist or wet places, breathing water through spiracles at the posterior end. The pupae greatly resemble the larvae in shape and color until nearly time to develop into the adults, when the wings and legs begin to appear. The body segments are provided with sharp spines which project backwards and by which they are able to wriggle to the surface when ready to emerge. The broods overlap so that all stages may be found. The insect probably hibernates in the larval forms and pupate early in the spring, giving rise to the adults. These bring forth young larvae, which become destructive early in the summer.

Food Plants

The larvae feed entirely upon the roots of plants. Undoubtedly a great variety are attacked. Serious damage has been reported, due to its ravages in alfalfa and clover fields.

Control

The greatest amount of damage is usually done in fields which have long been seeded to alfalfa or clover, where the breeding has not been disturbed. Plowing and thorough cultivation will destroy most of the larvae, which are either crushed or die for lack of sufficient moisture. The females being wingless are unable to migrate sufficiently to cause serious damage in one year. A cultivated crop once in two or three years as a rotation with clover or alfalfa is recommended when the destructiveness of the pest warrants strict remedial measures.

Natural Enemies

Carnes and Newcomer report a tachinid fly as parasitic upon the larvae.

E. O. Essig

Alfalfa Looper

Autographa gamma californica Speyer

(Family Noctuidae)

General Appearance

The adult moths have a wing expanse of about one and one-fourth inches with the body a little over one-half an inch long. The fore wings are light bluish-gray with rose or rust-colored and light markings, a very distinctive feature of which is one shaped like the Greek letter gamma near the middle. The hind wings and body are dull gray. The eggs are hemispherical and pale yellow.

The young caterpillars are light green while the fully developed forms are dark olive-green; head light green; three dark longitudinal lines on the body; a dark spot back of the eye. There are three pairs of well-developed front legs, two pairs of abdominal legs just back of the middle, and one pair at the extreme posterior end. When full grown the larvae attain a length of about one inch. The cocoon is loosely spun of white silk; the chrysalis being brownish black in color, or paler.

Life History

According to J. A. Hyslop, of the United States Department of Agriculture, this insect passes the winter in the pupal and adult stages, the moths appearing early in the spring and are especially active, laying eggs in May and June in the alfalfa fields. The young larvae or loopers are plentiful in June, feeding upon the leaves of the plants. In about two weeks they are full-grown and spin a loose white cocoon among the leaves, in which to pupate. After twelve days the adult moths emerge. The entire life cycle requires about a month. There are two generations a year—the second broods coming on in July.

Food Plants

The larvae are very destructive to alfalfa, working upon the leaves and blossoms. They also feed upon clover, garden peas, cabbage, barley, elder, dock and wild malva.

Natural Enemies

As very well shown by Mr. Hyslop, this insect is so held in check by natural enemies that artificial remedies are yet unnecessary. Internal hymenopterous parasites and tachinid flies are responsible for the good work. In the state of Washington five of the former and two of the latter have been recorded.

Alfalfa Weevil

Phytonomus posticus

This threatening pest belongs to the snout beetle family. Its native home seems to have been the shores of the Mediterranean sea. It appeared first in this country in Utah, about 1904. It had spread by 1914 to the greater part of the alfalfa district of Utah, to several counties in the southwestern part of Idaho and several points in Wyoming.

It feeds upon other legumes besides alfalfa but does its greatest damage there.

Life History

The eggs are laid in April, May and June, two to thirty in number in one place in the stems of the alfalfa in feeding punctures. Females, under favorable conditions, lay several hundred eggs during the egg laying period. The eggs hatch in 10 to 12 days and the larvae begin feeding in the tender stems. After a few days they emerge and find a leaf bud which they enter and feed in concealment. The larva passes through its three moults in three to seven weeks, pupates and emerges in about nine days thereafter.

The adult is less than one-quarter of an inch long and covered with short, dark brown hairs mixed with gray and black. They do great damage to the stems and leaves of the alfalfa. With a few exceptions they do not reproduce until the following spring, overwintering in the crowns of the alfalfa and in trash about the fields. They spread mainly by flight, soon after emerging as adults, assisted by the winds. Also in freight cars, wagons, irrigating ditches, hay, etc. The state of California maintains a quarantine against both Idaho and Utah.

Control

Numerous methods have been tried for the control of the alfalfa weevil. The one that seems to be the most promising on a large scale is that of going over the field after each cutting with a spring-tooth harrow with a wire brush attached. This crushes a good many of the weevils and larvae and raises a dust which is distasteful to them. It also forms a dust mulch helping to conserve moisture and stimulates the alfalfa to vigorous growth. The cost of this method is $2 to $5 per acre, according to Merrill.

References

Utah Experiment Station Bulletin 110.

Bureau of Entomology Bulletin 112.

California Commission of Horticulture, I, Nos. 1 and 10.

BEAN THRIPS. See under *Bean.*

Clover or Almond Mite

Bryobia pratensis Garman

General Appearance

The young mites are red, becoming brown when fully developed. Though very much smaller than a pinhead this species is much larger than any of the common destructive mites in this state. The eggs are very minute, so small as to be scarcely visible to the naked eye; globular and red.

Life History

The eggs deposited in the fall hatch with the first warm spring weather and the mites at once begin to work. Their development is very rapid and reproduction exceedingly great, so by summer there are often sufficient numbers to do great damage. Breeding and work continue until fall, when the eggs are laid and operations suspended until these hatch in the spring.

Food Plants

This mite is an omnivorous feeder and may be found upon a great variety of plants. Peas, clover and alfalfa are severely attacked, while they also feed upon grass, grains and buckwheat. Peach, apple, plum, apricot, prune, cherry, almond and quince trees are also among the food plants.

Control

For this pest Mr. W. H. Volck especially recommends the following formula: Water, 100 gallons; flour paste, 4 gallons; lime-sulphur solution, 5 quarts; iron sulphate, 2 pounds. The flour paste and lime sulphur are thoroughly mixed in the spray tank after which the iron sulphate is added and all thoroughly agitated.

Natural Enemies

The larvae of the minute black ladybird beetles (*Stethorus vagans* Blackb. and *Stethorus picipes* Casey) and the green lacewing (*Chrysopa californica* Coq.) prey upon the clover mite but they do not appear to be important factors in keeping it down.

E. O. ESSIG

GRASSHOPPERS

Valley Grasshopper

Œdaleonotus enigma Scudd

General Appearance

One of the smaller species, the adults being about one-fourth of an inch long. The general color is rich amber with reddish hue around the eyes. The dorsum and carinae of the thorax are dark. The tegmina are mottled with black and dusky spots. The antennae and first two pairs of legs are concolorous with the body, while the femora of the hind legs are richly marked with black and the tibiae are pale blue. The young are nearly of the same general color, with the dark markings less pronounced.

Life History

The holes in which the eggs are laid are usually drilled in hard or compact soil. The eggs are laid regularly and horizontally and cemented together, as well as being surrounded with a liquid cement which renders the mass waterproof. The young hatch the following spring, as soon as it becomes warm and they begin to reach maturity early in June. Pairing begins soon after and eggs are deposited from August to October. There are two forms of the adults, characterized by long and short wings. The species is very prolific and does much damage. It is only occasionally migratory.

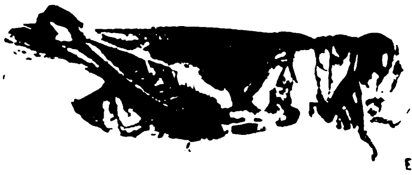

Fig. 1. The Valley Grasshopper (*Oedaleonotus enigma* Scudd). (Original.)

Food Plants

All forms of vegetation, including the foliage of orchards and vineyards, uncultivated field crops, such as alfalfa, clover, grain, etc., and cultivated crops, such as vegetables, corn, potatoes, etc., are attacked.

Differential Grasshopper

Melanoplus differentialis Thomas

General Appearance

This is one of the larger hoppers, averaging one and five-eighths inches from front to the tip of the tegmina or wing covers. A very beautifully colored insect when fully matured. The head, thorax, abdomen and first two pairs of legs are amber or rich brown, the sutures being dark. The wing covers are brownish gray—the true wings being transparent. The hind femora are yellow with black cross lines, while the tibiae and tarsi are bright red, the former with black spots near the outer base. The spines and claws are black. The antennae are reddish with dusky tips. The nymphs are green.

Life History

Egg-laying begins about the middle of the summer. The holes for the eggs are drilled into the soil in bare and vacant places, especially in alfalfa fields. From 60 to 80 eggs are laid by each female. They are protected from winter rains and freezes by an excretion of the female which makes the capsule containing them waterproof. They begin to hatch in the warmer spring months, appearing early in June and keep up their destructive work until August. The young green hoppers, as they mature, acquire wings and assume a yellowish tint, thus causing the belief that there are two distinct species. The largest brood appears early in the summer, and the greatest amount of damage is done by the first of August.

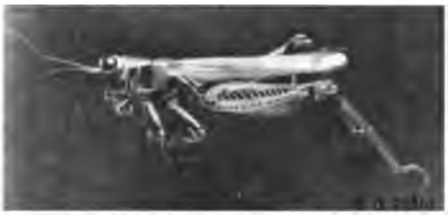

Fig. 1. The Differential Grasshopper (*Melanoplus differentialis* Thomas. (Original.)

Food Plants

Practically all kinds of green vegetation, including most of the forage and truck crops. Especially destructive to alfalfa. Orchard trees and vineyards are also attacked, some trees and vines being completely defoliated and many killed.

Hopper Dozer

The use of the hopper dozer has become an important factor in the control of grasshoppers, especially in grain and hay fields, in pastures and even in cultivated crops. The hopper dozer is constructed as shown in Fig. 1. The back and sides are made of thin sheet iron or cloth and the pan at the bottom constructed to hold about two inches of kerosene. These dozers may be made any length but a two-horse size is the most practicable. They are simply drawn across the fields and capture the hoppers as the latter endeavor to escape their approach. Though the hoppers may escape from the kerosene bath they are doomed.

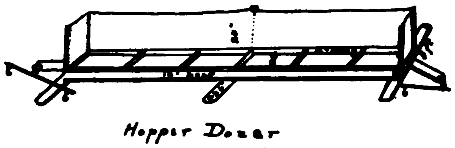

Fig. 1. Plan of a Very Good Hopper Dozer. —*After Urbahns.*

The best time of operation is on warm days if possible, early in the season before the hoppers have acquired wings.

A brief description of some of the most common and destructive California species follows.

E. O. Essig

Grape Leaf Hopper. See under *Grape.*

Zebra Caterpillar

Mamestra picta Harris

The zebra caterpillar often attracts attention by appearing in considerable numbers in the early fall on alfalfa.

Comstock * describes the caterpillar as of a light yellow color with three broad longitudinal black stripes, one on each side and the third on the top of the back. These stripes on the sides are broken by numerous pure white lines. The pupa is of a brownish color. The adult moth has dark chestnut brown forewings and pale yellow hindwings.

The eggs of this caterpillar are deposited on the alfalfa leaves and hatch in a few days. The young larvae eat the epidermis of the leaves, which soon appear whitish from their attack. They web the tops of the stalks of alfalfa together.

One may go through an alfalfa field and notice here and there plants of which the tops are webbed together and the leaves present a whitish and dead appearance. In the young stages the larvae work in colonies, and only on the upper and consequently more tender portions of the alfalfa plant. I have seen as many as 50 small larvae on one leaf and several hundred on the entire plant. As they become larger they will scatter to adjoining plants, eating the leaves as they go. Often at a radius of several feet from the originally infested plant the larvae may be found working on the leaves.

From September to October the caterpillars on becoming full grown enter the soil to pupate. The winter is passed in this stage, the moths appearing in the spring. There are probably several generations, but the last generation in the fall is the one in which the larvae are numerous enough to attract attention.

At present the best method for the control of this pest on alfalfa is to go through a field picking and destroying infested tops, which are conspicuous because of their whitish color, when the larvae are in the young stages and consequently massed on one or two stalks. If the fields are pastured at this time of the year very little damage will result from this insect's attack.

This insect occurs in the Atlantic states, Colorado, Utah and California.

Besides alfalfa, it attacks cabbage, celery, beets and other garden vegetables.

E. J. Vosler,
Cal. Com. Hort. II. 11.

Cocoanut Palm

The cocoanut palm grows in the tropics along the seashore in rich sandy soil. It is native to the islands of the Indian ocean and is now widely distributed throughout the tropical countries of the world. The only part of the United States where it grows in any considerable quantities is in the southern part of Florida, but even here it does not succeed so well as farther south, showing that it must live in a climate practically free from frost.

Geological specimens have been discovered in Central and South America, showing that it once had a much wider distribution than at present. In the tropical islands it has been discovered to be one of the first trees to find a foothold upon the newly formed soil. It is a luxurious grower, often reaching a height of more than 100 feet with leaves from 10 to 20 feet in length. At the bases of the leaves appear large yellow or white flowers followed by large, hard-shelled nuts. The tree usually begins to bear at the age, or about the age of ten years, and continues fruitful for more than half a century. It flourishes best in lands near the coast that are so sandy and shelly that little else will grow.

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* Manual for Study of Insects, page 305.

The cocoanut is propagated wholly from seeds, which when planted in the nursery, and grown for commercial purposes, are planted in rows, and when the plants are large enough, are transplanted into the orchard and set about 20 to 30 feet apart. For a few years, they are given clean cultivation, and then allowed to shift for themselves because they grow in soil not adapted to other vegetable growths.

The cocoanut palm is one of the most important nut trees of the world. Its fruits are used in many ways in the tropical countries, either cooked, raw, ripe or unripe. Large quantities are exported to temperate climates, where it is used by confectioners for the making of candies, cakes and bread. The oil is used in making candles, soap and for cooking. The central parts of the stems of the young plant and the terminal buds of the old plant are often used as vegetable food or salad. The dried leaves are used for thatching and there is a sap drawn from the young spathes, out of which a pleasant drink is made. The lower wood of the old trunk is used in cabinet making, the fiber is sometimes used for cordage, while the shell is used for drinking cups, bowls, bottles and sometimes polished for ornamental purposes. Perhaps there is no fruit more profitable, in proportion to the amount of labor expended in its production, than the cocoanut.

Granville Lowther

Cola Nut

A small tree, growing to the height of 20 or 40 feet, native to the west coast of Africa and about 500 miles into the interior between Sierra Leone and Lower Guinea. The tree has become naturalized in the West Indies and Brazil. There are about 14 species of trees, and the fruit, or nut, is supposed to possess a stimulating power as well as nutritive value that sustains the natives in great feats of endurance.

It bears a profusion of purplish flowers, from which grow a brownish yellow fruit, which encloses a nut of red and white seeds. In its tenth year, the tree reaches its maturity, so that it bears more profusely than at any other period. The seeds ripen in October or November and will yield as much as 125 pounds per tree.

The extract of the nut is believed to possess medicinal qualities and has recently come into use in many parts of the world as a beverage.

Granville Lowther

Colorado

Colorado gets its name from the Colorado river, a name meaning "red or reddish." It is 380 miles from east to west, and 275 miles from north to south, making a land area of 103,645 square miles or 66,332,800 acres.

Colorado includes an important part of the Rocky mountain range, which is the natural divide between the drainage systems of the Middle states, and the Pacific coast states. Much of it is rough and fit only for mining and grazing, which industries yield its principal wealth. It contains more land at higher altitude than any other state in the Union. About three-sevenths of the state is an elevated plateau, rising gradually from east to west, until it reaches the vicinity of Denver. East of this its water drains through the South Platte and Arkansas Rivers into the Missouri and Mississippi and into the Gulf of Mexico. Westward its waters drain through the Colorado river into the Gulf of California. The eastern one-third of the state is part of that great plain called the Mississippi valley, the western portion of which a generation or two ago, was considered a part of the "Great American Desert," but which is now being rapidly brought under profitable cultivation.

In the mountainous portions are narrow valleys of alluvial soil, washed from the mountain sides, some of them rich and well adapted to farming and grazing. The orchards are almost always in the valleys, for several reasons. First, the elevation is too great, and the climate too severe, in the higher lands, for the growing of fruits. Second, generally irrigation is required for the growing of fruits, and irrigation is not possible on the high plateaus. Third, orchards need to be sheltered from the winds and for that reason need a cove, valley or protected place. From her many peaks and high mountain ranges, the highest portions of which are always covered with snow, hundreds of streams are fed, from which water can be diverted for irrigation, and thus some of the valleys are becoming sources of plenty.

Fruit growing is the leading industry, in the counties of Delta, Mesa and Montrose, along the Grand river. It is here that the famous Grand Junction district is situated. On the Arkansas river, the principal fruit section is around Canyon City, although considerable fruit is grown farther down the river near Pueblo and farther east. Canyon City is famous for its cantaloupes, as also is the Rocky Ford district which has given its name to the netted gem variety of cantaloup.

Prof. E. R. Bennett, of the Colorado Agricultural college, thinks that fruit growing in mountain districts is in a class by itself. He thinks that the Rocky mountain district differs from any of the other four great districts of North America. The districts here referred to are doubtless the Pacific coast states, the Alleghany mountain region, the Ozark mountain region and the region of the Great Lakes. He has the following in substance to say in regard to the differences. "The difference is primarily due to altitude. Plant tissue in the high altitudes is characterized by a delicacy of cell structure which, noticably in forest trees, makes them brittle. Such trees for instance as the elm, ash and maple which easily withstand the heavy ice storms of the East, are frequently broken in Colorado by storms less severe. This is manifest in fruit in a finer texture so that apples, naturally tough in character, are better when grown in the Rocky mountain district than when grown in lower altitudes. Another fact, that may be either good or bad, is that high altitudes tend to make flavor less prominent. For this reason, the Baldwin and Greening are desirable varieties when grown in New England, but are too insipid when grown in Colorado. On the other hand, the Jonathan grown in the high altitudes is just sufficiently toned down to give it a desirable flavor, without that acrid taste which characterizes it when grown in the East. Another feature of the orchard industry in Colorado (and in all the Pacific coast states as well) is the early bearing habit of the trees. In the East it is not expected that an orchard will bear to any considerable extent until it is from 8 to 15 years old, while the Colorado orchards will make a much more rapid growth and bear at half that age.

"The apple is the most important fruit of the Rocky mountain district. The number of bearing trees in Colorado is over 2,750,000. In 1910 there were of all kinds of fruit trees set 1,873,870. In 1911 it is estimated there were about two millions. It is difficult to estimate the value of orchards in the Rocky mountain district as these vary considerably with the different places in which they are grown. Some are located in small valleys more or less distant from railroads, and where the lands are not well advertised. In such places bearing orchards would sell for $200 to $500 per acre. In other places, where the orchard areas are larger, the transportation facilities better, and where more advertising has been done, orchards will sell from $700 to $2,000 per acre. The yield per acre for bearing trees is from 150 to 500 boxes; perhaps an average of 250 boxes per acre would be a fair estimate. The net income per acre will probably be all the way from $100 to $200.

"The apple-growing industry in Colorado is rapidly increasing because of the average high market price received for Colorado apples. Apples sell in the markets of the East at a higher price than from any other district except those of the Northwest, so that the proposition from the standpoint of the grower is one of high-class fruit. Colorado orchardists do not claim that fruit can be grown cheaper in the Rocky mountain district than in the East, or that cheap grades of fruit are profitable in this district. The aim of the orchardist is to grow fruit that will sell in the best markets rather than fruit for the low class trade of the country.

"From the standpoint of soils it would be hard to say what would be considered a typical Colorado soil. Orchards are successfully grown on soils all the way from heavy, adobe bottom lands to the lightest sand and gravel soils of the higher mesas. The essential thing is sufficient fertility and water enough to enable the trees to develop the fruit in the best manner.

"The most important fruit for the Rocky mountain district aside from the apple is the peach. Peach growing in the state is largely limited to the protected valleys where the air drainage is such as to give a minimum of losses from late spring frosts and extremes of cold in winter. Palisades in the valley of the Grand, Paonia in the North Fork valley, and a few other districts comprise the larger part of the peach territory of the state. These lands that are particularly well adapted to peach growing have become world famous for their great returns from peaches. A thousand dollars per acre was once not an uncommon return from peaches, and peach orchards have been sold as high as $4,500 per acre.

"The pear is still more localized in its production owing largely to the ravages of the pear blight which has made pear growing a precarious business in some districts. Districts that are well adapted to pear growing and are not seriously troubled from this disease, have made big returns from the industry. The pear, however, is not increasing in production in this state to any such extent as are many of the other fruits.

"Not the least important of the fruit products of Colorado is the cherry. The cherry is adapted to a greater variety of soils and conditions in Colorado than any of the other fruits except possibly the apple, and in fact the cherry will grow without irrigation in many districts where the apple is not particularly successful. In the west slope districts as in the valleys of the Grand, Uncompahgre, North Fork, Animas and in Montezuma county, the sweet cherry is grown possibly more extensively than the sour. On the east side of the mountains the sour cherry predominates. Of the sweet cherries, the Royal Ann (Napoleon), May Duke, Royal Duke and Bing are more largely grown. Of the sour cherries the Montmorency, Morello or Wragg are the leading varieties. The sweet cherry is largely marketed fresh in boxes. Some of the sour cherries are utilized in the same way, although there is a growing tendency towards canning the product at canneries near the orchards. The cherry will make a gross return of from $200 to $400 per acre, and is one of our most dependable fruits as fewer failures come in cherry growing than with most other fruits."

Grand Valley

The Grand valley is situated on the western slope of the Rocky mountains, in Mesa county, and extends westward to the Utah line. It has an altitude of about 4,600 feet, is about 40 miles long, and 6 to 10 miles wide. It contains approximately 150,000 acres of land, capable of irrigation, some of which is already under water and planted to orchards, while about 60,000 acres will come under the Government irrigation project now in the process of construction. The principal crops are apples and peaches. Of the varieties of apples best adapted, the Jonathan is the favorite. Here the soil and climatic conditions seem favorable for its growth and a high state of perfection is reached.

GRANVILLE LOWTHER

Grand Junction Weather for the Past Sixteen Years

Temperature

The mean annual temperature is 52.6 degrees. The highest annual mean was 54.5 degrees in 1900, the lowest 50.1 degrees in 1903. The highest temperature ever recorded was 104 degrees on June

23, 1900, the lowest —16 degrees on January 26, 1898; other low temperatures were —15 degrees, February 7, 1903; —14 degrees, February 14, 1905, and —12 degrees, February 6, 1899. The coldest month was February, 1903, with a mean temperature of 15.2 degrees, the warmest was July, 1901, with a mean of 82.0 degrees. In February, 1903, there were 14 days on which the temperature was below zero. In July, 1901, there were 12 days with temperature 100 degrees or more, and the temperature exceeded 90 degrees on every day of that month.

Precipitation

The mean annual precipitation is 8.22 inches. The greatest annual fall was 11.61 inches in 1906, the least, 3.64 inches, in 1900; other heavy falls were, 11.25 inches in 1897, 10.87 inches in 1899, 10.85 inches in 1895, and 10.25 inches in 1905. The greatest monthly fall was 3.76 inches in September, 1896, and the least, none, in September, 1892, and November, 1904. The greatest fall ever recorded in any 24 consecutive hours was 2.16 inches on September 22-23, 1896. The average annual snowfall is 19.0 inches. The greatest annual amount was 35.9 inches in 1905, the least, 1.2 inches in 1900.

Wind

The average hourly wind velocity is 5.1 miles per hour. The prevailing directions are S.E. and N.W. The highest velocities recorded were 41 miles per hour from the N.W. on February 22, 1900, and 41 miles from the S.W. on April 1, 1903. The winds are generally E. to S.E., from midnight to noon, and W. to N.W. from noon to midnight.

Sunshine and Cloudiness

The sunshine has averaged 70 per cent of the possible amount. The month of greatest sunshine is July; of least, January. The average of clear days is 193; partly cloudy days, 102; cloudy days, 70. The average number of days with fog is 1; with hail, 2; with thunderstorms, 35; with .01 inch or more precipitation, 57; with .04 or more precipitation, 40.

Compiled from U. S. Weather Bureau Records.

Frost and Precipitation for Colorado

Station	Frost				Precipitati'n
	Average Date of		Date of		
	First Killing in Autumn	Last in Spring	Earliest Killing in Autumn	Last in Spring	Annual inches
Fort Collins	Sept. 21	May 13	Sept. 7	June 5	14.6
Leroy	Sept. 26	May 5	Sept. 12	May 26	15.0
Meeker	Sept. 12	June 7	Aug. 23	July 4	15.0
Pagoda	Sept. 8	June 10	Aug. 20	July 19	19.7
Silt	Sept. 25	May 18	Aug. 27	June 6	11.8
Breckenridge	....	....	....	....	26.8
Denver	Oct. 4	May 7	Sept. 12	June 6	13.7
Cope	Oct. 3	Apr. 27	Sept. 11	May 22	18.4
Grand Junction	Oct. 29	Apr. 11	Sept. 14	Apr. 30	7.7
Colorado Springs	Sept. 28	May 1	Sept. 12	May 23	14.3
Hamps	Sept. 21	May 16	Sept. 6	June 8	13.1
Montrose	Sept. 29	May 10	Sept. 8	May 28	9.3
Gunnison	....	....	....	....	8.9
Salida	Sept. 7	May 30	Aug. 25	July 7	9.7
Pueblo	Oct. 15	Apr. 28	Sept. 12	May 23	11.6
Las Animas	Oct. 6	May 2	Sept. 7	May 19	11.4
Saganche	Sept. 17	May 24	Sept. 10	July 6	7.1
Durango	Sept. 22	May 13	Aug. 24	June 12	15.9
San Luis	Sept. 11	June 9	Aug. 25	July 5	11.9
Hoehue	Oct. 2	May 10	Sept. 13	July 4	13.0
Blaine	Oct. 6	May 13	Sept. 7	May 22	15.3

Composition of Irrigated and Non-Irrigated Fruits

J. S. Jones and C. W. Colver in Idaho State Bulletin No. 75 report an analytical study of orchard and small fruits, with special reference to the effect of irrigation on those compounds which materially influence quality in fruit. Although the attempt has been made to compare similar varieties of fruits growing both under irrigation and non-irrigation, data were secured with regard to as many varieties as possible whether grown under both conditions or not. The principal determinations made include total solids, acidity, invert and cane sugar, nitrogen, ash and waste. The leading commercial districts of Idaho were represented and all samples were grown at elevations less than 3,000 feet. The analyses are here grouped and discussed under the three divisions of drupaceous, pomaceous and small fruits.

Summarizing the results it appears that there is a fairly well-defined tendency for apricots, cherries, nectarines, peaches, plums and prunes to elaborate greater percentages of solid matter when grown in the non-irrigated sections. With the exception of Italian and Petite prunes, however, such differences in sugar and acid are too small to seriously affect taste. There was a remarkable uniformity of composition within each of the several varieties of apples analyzed. The non-irrigated varieties contain slightly greater percentages of acid and sugar, but the differences practically disappear when these constituents are calculated to the dry or solid matter. Apples grown with irrigation contain the smaller percentage of solids insoluble in water, and the non-irrigated apples containing appreciably higher percentages of crude protein, and consequently may have a slightly higher actual food value. In intensity and uniformity of color, also in percentage of waste, irrigated apples are somewhat superior to the non-irrigated.

With the exception of strawberries there were but slight differences in percentage of solid matter and in the total sugar content between the irrigated and non-irrigated small fruits. The non-irrigated small fruits, however, contain appreciably greater percentages of acid and of crude protein.

From a survey of the analytical results as a whole the authors are led to conclude that fruits in general manifest a well-defined tendency to elaborate greater percentages of total solids or dry matter, consequently of sugar, acid and crude protein when grown in non-irrigated sections, but that with comparatively few exceptions no marked difference between irrigated and non-irrigated fruits in actual food or market value should be charged to differences in composition.

Cost of Hauling Fruits to Market. See under *Marketing*.

Connecticut

Connecticut has an area of 4,850 square miles. It may be divided into coast land, central low land, and eastern upland. The central lowland is in the valley of the Connecticut river and is a sandy loam well adapted to diversified agriculture. That which is true of the Connecticut river is also true of the bottoms along the other streams, except that the valley of the Connecticut is larger than any of the others. The soil in the upland is, for the most part, a heavy clay. There is a considerable difference in the periods of the ripening of fruits. In the bottoms the climate is warmer on account of the radiation of the heat and sunshine from the hillsides, and the soils are sandy and warm, and therefore, produce crops that mature and come into the markets before the fruits of the same varieties on the uplands are ready to pick.

Apples grow anywhere in the state, but the hills and the uplands produce the best winter varieties because they have the best keeping qualities, and therefore bring the highest price in the market. The soil of the hills seems well adapted to the growing of the best varieties.

Peach growing in Connecticut is proving to be an important industry. The only trouble seems to be on account of the danger of frosts that kill the buds in the early spring. It is estimated that on the lowlands there will probably be a loss of two crops out of five, while on the hills there is less danger, and there will be a loss of one crop out of five, or one out of four, and there are a few favored spots where there is scarcely any danger from frosts. The peaches of Connecticut are of a very fine quality, well developed, finely colored, and bring good prices in the city markets.

Grapes and pears are successfully grown in all parts of the state, and the small fruits do well. The only crop that seems not to succeed well is the cherry, of which it is estimated that there are scarcely enough grown to supply the home demand.

GRANVILLE LOWTHER

CO-OPERATION, FUNDAMENTALS OF. See *Marketing*.

Corn

This cereal is so common in the United States that it is scarcely necessary to devote space here to a description of its cultivation. For garden purposes there are three kinds in general use.

The first is the common field corn, cooked when the ears are not yet mature but after the grain has formed and called "roasting ears."

The second is "sweet corn," cooked in much the same way and used largely for canning.

The third is "pop corn," which after maturity and being thoroughly dried, is heated to a temperature which will cause it to explode into white crisp grains.

The field corn requires earlier planting than the other varieties because it is larger and it takes longer to bring it to maturity.

Sweet corn may be planted as soon in the spring as the danger of frost is past, and then if there are successive plantings every two weeks, it may be gathered for use from July until late in the autumn.

Pop corn is small and matures early.

Plant the seed in hills about three feet apart each way. While corn will grow on almost any kind of soil, a deep rich soil is preferable.

GRANVILLE LOWTHER

COVER CROPS. See *Apple Orchard, Cultivation of.*

COW PEAS. See *Apple Orchard Cover Crops.*

Crab Apples

In speaking of crab apples, most old settlers think of the "Native Wild Apples" which grew in the forests of the Eastern states, or in strips of timber and clumps or groves in the prairie states and the Oregon crab apple native to the Pacific coast.

The native wild apples, ***Pyrus coronaria***, were found by the early settlers in Canada and all the eastern and middle portions of the United States. The flowers are large, showy, white or rose colored and delightfully fragrant. The fruit ripens late, is sour, almost bitter, and was used by the frontiersmen mostly for making preserves. In the prairie states, this species varied so that some have regarded it a separate species and have named it ***Pyrus iowensis***. The fruit is small, measuring from less than an inch in diameter to two inches.

Pyrus augustifolia is the native crab of the Southern states; is much like ***Pyrus coronaria***, and need not be further described.

Pyrus rivularis, the Oregon crab apple, has rather small white flowers and the calyx lobes become deciduous from the mature fruits. The fruit is about three-fourths of an inch long, oblong, yellowish or blushed, and ripens in autumn. It is used by the Indians but is not cultivated.

Cultivated Hybrids

There are four varieties of cultivated hybrids, generally called crabs. These are the Soulard, Howard, Mercer and Kentucky Mammoth.

Common Crab Apple

The crab apples which we cultivate for their fruit are for the most part hybrids between the apple, ***Pyrus malus***, and the primitive Siberian crab, ***Pyrus baccata***.

The principal list of Siberian crab apples and their hybrids are as follows:

Bailey Crimson; fruit medium or large, skin yellow and shaded with a deep rich crimson.

Brier; tree vigorous and hardy, comes into bearing young, skin pale yellow, washed with a lively red.

Cherry; fruit medium to large, skin pale yellow, nearly covered with bright red.

Coral; fruit of good size, brilliant color, sprightly subacid in flavor, season October to February. The tree is a good bearer, and comes into bearing early.

Currant; fruit small, borne in clusters, of no commercial value.

Dartmouth; fruit large, brilliantly colored, good in flavor and quality. The tree is not a vigorous grower but comes into bearing early and yields full crops in alternate years.

Excelsior; fruit very large, nearly as large as the medium sized apple; very attractive in appearance and excellent in quality for either dessert or culinary uses. Tree a good strong grower, hardy, healthy and comes into bearing early, yields crops on alternate years. Skin smooth, yellow, shaded and splashed with red.

Florence; tree bears young, is a reliable cropper, prolific, fruit of good size, very attractive in appearance, of good quality, mostly overspread with a brilliant pinkish red.

Gibb; fruit large, yellow blushed with dull red, highly esteemed for canning, season last half of September. Tree well adapted to northern sections, slow grower but very productive.

Hyslop; fruit large, very brilliantly colored, dark red or purplish, overspread with thick blue bloom; borne in clusters. The tree is a good grower, very hardy, and a reliable cropper, heavy crops every second year, sometimes annually.

Large Red Siberian; fruit of medium size for the Siberian, being larger than the Red Siberian, but smaller than the Transcendent or Hyslop. Tree is a vigorous grower, hardy, healthy, and a heavy cropper, bears biennially, sometimes annually.

Large Yellow Siberian; fruit large, clear pale yellow with a shade of red. Tree medium in size, moderately vigorous, very hardy, healthy, comes into bearing young, is very productive. Is generally superseded in the markets by the larger varieties.

Marengo; very good variety for home use, where late keeping is required, but larger and more attractive varieties are generally preferred.

Martha; fruit large, very handsome clear yellow, more or less overspread with a bright red; excellent in flavor and quality. Tree medium size, very hardy, comes into bearing young, yields good crops annually. Season from September to late fall.

Minnesota; fruit very large for its class, skin pale yellow blushed or mottled on the sunny side, flesh white, firm, crisp, season from September to October.

Montreal Beauty; a very beautiful fruit, tree less hardy than the Transcendent, does not come into bearing early, but bears heavily. Fruit large, for its class, yellowish green mostly covered with red.

Oblong; fruit medium size, medium all around and not generally recommended.

Orange; regarded by some as a desirable variety for both home use and market, but no distinctive characteristics that make it particularly desirable.

Paul Imperial; fruit small to medium, somewhat irregular in shape, of very good appearance but less attractive in size and color than the Hyslop, and inferior to the Martha in quality. Tree below medium in size, comes into bearing young and is an annual cropper.

Picta Striata; fruit handsome, rather mild in flavor, but is hardly large enough for a good commercial variety.

Quaker; a late ripening variety only fair in quality, size medium to large; color yellow with red cheek, tree handsome but not very productive.

Queen Choice; fruit medium or above in size, of a beautiful crimson color, showy and attractive, tree vigorous, very prolific.

Red Siberian; fruit small, decidedly ornamental, borne in clusters. Skin smooth, pale yellow, striped and blushed with a lively red overspread with a bluish bloom.

September; a very handsome fruit of good quality; ripens a few days later than the Transcendent, in September. Tree a good grower, comes into bearing young and yields good crops biennially.

Soulard; is regarded as a hybrid between the common wild prairie crab and the common apple. It originated on a farm near St. Louis, Mo. It is large, of good quality, and one of the most desirable of all varieties produced in the United States. It is good when baked, makes excellent jams, jellies and preserves, hangs on the tree until late frost and will keep in common storage for a year. Tree perfectly hardy. It seems not adapted to the Northeastern states, and in some other portions of the United States has not been sufficiently tested.

Transcendent; a beautiful fruit and one of the most popular. Tree a good grower, hardy, very prolific, fruit medium to large, clear bright yellow with red cheeks; season late in August to middle of September.

Van Wyck; a sweet crab apple, fruit large for a Siberian crab, whitish, shaded with bright red covered with bloom; inclines to watercore; season from August to September.

Whitney; one of the most popular of the large crab apples, especially in the West and North. Tree is thrifty, upright grower, comes into bearing young and is very productive. Season, August and September.

Yellow Siberian; is sometimes called the Golden Beauty. It is similar to the Red Siberian, except for size it is larger, and in color it is a clear golden yellow. Under certain circumstances it suffers from blight. It comes into bearing young, is a vigorous grower and a heavy annual cropper.

For further information as to the culture and the adaptation of crab apples to special locations, see *Apple*.

GRANVILLE LOWTHER

CRABS, AMERICAN. See *Apple, History of.*

CRAB APPLES, GRADE RULES FOR. See under *Apple Packing.*

CRABS, EUROPEAN. See *Apple, History of.*

CRABS, NATIVE, FUTURE OF. See *Apple, History of.*

CRAB, SOULARD. See *Apple, History of.*

CRABS, WILD. See *Apple, History of.*

CRABS, SMOOTH, WILD. See *Apple, Botany of.*

CRABS, HAIRY, WILD. See *Apple, Botany of.*

Cranberry

There are two species of cranberry; one is known as the Little Cranberry, *Vaccinium oxycoccus*, and the other as the Large American Cranberry, *Vacinium macrocarpon.*

The American cranberry grows wild along the Atlantic coast from Maine to New Jersey, and in small areas along the Allegheny mountain range from Southern Pennsylvania to North Carolina. It grows also in some of the Middle states like Michigan, Wisconsin and Minnesota.

The number of acres planted to cranberries according to the census reports of 1910 are as follows: Connecticut, 275; Illinois, 1; Indiana, 70; Iowa, 1; Kansas, 1; Maine, 90; Massachusetts, 5,128; Michigan, 150; Minnesota, 22; Nebraska, 1; New Hampshire, 23; New Jersey, 8,356; New York, 113; Oregon, 6; Rhode Island, 300; South Dakota, 1; Washington, 5; Wisconsin, 5,821.

One of the most surprising things in the study of cranberry culture is the average number of bushels per acre in the sections where the fruit is grown for commercial purposes. The lowest average per acre is in Maine, where it is 17 bushels. The highest average per acre is Oregon where it is 119 bushels per acre. Next to Oregon is Massachusetts giving an average yield of 117 bushels per acre and next to Massachusetts, New York with 96 bushels per acre. The average for the cranberry producing states is within a fraction of 47 bushels per acre. It would appear therefore that the states producing above this average would make the industry profitable, and that Oregon and Massachusetts should make it very profitable.

Structurally the cranberry is allied to the blueberry or huckleberry; but botanically it is classed as a distinct species.

Soils Best Adapted

It is necessary to success in cranberry culture that the soil should be very rich in humus, boggy and mixed with sand. The water should be within a few inches of the surface, and during the growing season, the whole area should be flooded as in the growing of rice in the South. The cranberry is not, however, a Southern plant but grows either in the northern latitudes or the high altitudes which make the climate equivalent to a northern latitude. On account of the necessity of maintaining a water level, land should be chosen that has a substratum of hard pan, impervious clay, or something that holds the water, so that while the plants are growing the water may be held from six to ten inches below the surface, and when they are fruiting the water should be held at from one to two feet deep below the surface.

On this account, the land should be level, or it cannot be uniformly covered to a sufficient depth. In order to do this, it is better to make a small embankment around the tract to be irrigated. These embankments need not be more than about three feet in height, and if the land is sufficiently leveled, they will hold the water to any depth needed in the growing of the fruits.

Grading

The work of grading the land should be done with a good deal of care, destroying all roots of plants, shrubs, and whatever may obstruct the growth of the fruit. The land should be then carefully smoothed down to a level and sanded. The sanding is a process that may require much labor, depending on the distance sand must be hauled. The sand should be scattered over the land to a depth of about four inches.

Propagation

The propagation of the cranberry for commercial purposes is by means of cuttings, but for the production of new varieties seeds are planted as in most other kinds of fruit. The cuttings are planted as early in the spring as possible and the land kept sufficiently flooded to protect the plants from frost.

Methods of cranberry culture differ in different localities. L. C. Corbett, Horticulturist for the Department of Agriculture, conducted an investigation some years ago into this subject and the results are in part embodied in what follows.

Cuttings

[*] New cranberry meadows are almost always established by planting cuttings. The sanded surface of the area to be planted serves as the propagating bed for the cuttings as well as the home for the established plants. The cuttings consist usually of portions of shoots of the variety to be grown, 10 to 15 inches long. The common practice is to secure the cuttings from vigorous plants by mowing a portion of the meadow with a mowing scythe. The portions of the vines thus secured are then transported to the area to be planted and separated into wisps containing from 8 to 15 separate stems. The wisps are placed at the intersection of marks made to indicate the interval between the plants, usually 18 by 18 or 9 by 18 inches. The cuttings are then forced into the sand with a broad, thin, wedge-shaped dibble. The blade of the dibble is placed midway of the wisp of cuttings, so that the pressure exerted upon the cuttings doubles them upon themselves and at the same time presses them firmly in the soil.

While the above statement explains the usual method of propagating the cranberry, new meadows have been established by running the cuttings through an ordinary hay or straw cutter, thus reducing them to fragments about one inch long. By sowing these fragments in rows or broadcasting them upon the surface, a stand of plants may be secured. Cuttings of the cranberry intended for shipment should be loosely packed in well ventilated barrels, baskets, or crates. More injury results from the heating of the plants in closely packed, unventilated receptacles than from drying in well ventilated ones.

Harvesting

In early days of cranberry culture harvesting was necessarily done by hand. As the industry expanded, the increased demand for pickers rendered it necessary that in order to hold the cost of production within reasonable bounds some mechanical device be found which would lessen the cost of harvesting by increasing the quantity an individual is able to pick. This demand has been met by cranberry rakes, which effect a decided saving of time and expense, as one person can gather 75 to 80 measures of six quarts each in a day, while a hand picker can not gather more than one-half of that quantity. There is considerable prejudice among growers against the use of these harvesting devices because of some real or imagined injury to the bogs. This prejudice, however, seems to be disappearing; at least the use of the harvesters is each year becoming more general.

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[*] Farmers' Bulletin No. 176.

Harvesting is paid for, as a rule, by the measure. Each person is furnished with a rake and with pails or boxes in which to place the berries as picked. The meadow is then laid off in sections or strips by stretching lines across it. Each picker is assigned to a division. By this arrangement each one gets his share both of heavily and sparsely fruited plants, and the grower is certain of getting the product from all parts of the meadow. This has not been as satisfactorily accomplished in any other way. After being picked the fruit is carried to storehouses, where it is allowed to remain, until assorted, in the trays in which it was placed at picking time. The trays are of various dimensions to suit the fancy of the grower, but most of them hold about three measures (18 quarts) of fruit each.

Assorting

As the berries come from the field there are many broken branches, leaves and defective fruits among them. To remove the leaves and branches, various cleaning devices similar to the fanning mills used for cleaning grain have been invented. After having been winnowed in this fashion the fruit is spread upon assorting racks. Operators sitting upon either side of this device look over the berries in much the same manner as beans are looked over in hand picking. From the assorting table the berries go into barrels, a few only being crated.

Storing

Cranberries as they come from the field are immediately placed in storage buildings upon the plantation. It is the prevailing practice to hold the fruit in the storage houses at the bogs until the market is ready, which is from six weeks to three months after harvest. No artificial cold is needed in the storage houses. The only precaution necessary is to prevent the fruit from freezing, which frequently requires the use of a little heat in the storage house.

In early times it was thought necessary to pack the berries in casks and cover them with water in order to preserve them for any length of time, but this idea has been abandoned, and the fruit is for the most part stored in small open boxes.

Marketing

The fruit, as cleaned, assorted, and barreled, usually in ventilated barrels, is put on the market. The barrels are similar to those used for packing apples for the domestic market, and are practically of the same size. In the retail stores cranberries are more often found in bushel crates than in barrels. The crating of the fruit is done by the middlemen, who act as distributing agents, rather than by the producers. The dealers prefer that the growers pack the product in barrels.

Prices

By an examination of the price lists of the New York market from 1870 to 1902, it is found that the prices of cranberries have varied widely in that time. The lowest ranges of prices quoted were in April, 1879, when the berries sold at $3.50 to $4 a barrel; November, 1899, $4 to $7.50; April, 1889, $3.50 to $5.50; November, 1896, and January, 1897, $5 to $5.50; April, 1897, $3.50 to $5; and November, 1901, $6 to $7. The highest prices noted were $15 to $16 a barrel in April, 1874; $14 to $15 in April, 1876; $13 to $13.50 in January, 1884; $13 to $14 in March, 1895; and $10 to $12 in January, 1903. No prices are accessible for 1880, 1881, 1882, 1884, 1885, 1887, and 1888. The usual price has been from $7 to $10 a barrel.

Varieties

Selection for Planting

The kinds of cranberries vary as greatly in productiveness and habits of growth as do apples or peaches. As a result of this variation, many of the early planted bogs were not profitable, and had to be torn out and planted with a variety of greater commercial value. As with apples, those sorts which are largest and command highest prices upon the market are frequently shy bearers, and are only grown in limited areas to satisfy the fads of special markets. The question of the varieties best suited to any given section is one of a local nature, and must be determined by trial. In sections yet to be developed it may be found that the climate and soil conditions are particularly well suited to sorts that are shy bearers in the Cape Cod region, or the opposite may be true. For that reason those contemplating taking up this industry in a new section will do well to secure a number of different varieties of good repute from the various cranberry districts, rather than to place entire dependence either upon native stock or even the best sort from any other region. The history of the development of regions growing other standard fruits indicates that varieties are local.

CRANBERRY CULTURE IN THE PACIFIC NORTHWEST

C. N. Bennett

Clatsop Cranberry Bogs.

July, 1913.

General Description

Cranberry culture was established in Massachusetts about 1810; in New Jersey about 1850 and in Wisconsin about 1880, although the berries were gathered for commercial purposes from the wild vines many years before these dates. While these three states produce practically all the cultivated cranberries, they are grown in about one-third of the states. The United States is the only country where they are grown commercially.

In the Pacific Northwest the industry is comparatively new, but is by no means an experiment as bogs were established both in Pacific county, Washington, and Coos county, Oregon, about 1890, and at present they are grown commercially from Coos bay, Oregon, to Puget Sound, Washington.

There are probably not over 100 acres of bearing bogs along the Pacific coast, and the greater part of these have been neglected and are in poor condition, but there are a few bogs, where the owners understand and care for the bogs properly, that are producing good crops.

Within recent years interest has revived and bogs are now being scientifically constructed and superintended by practical and experienced men and within the next few years the cranberry industry on the Pacific coast promises to be of considerable importance. There are probably in the neighborhood of 200 acres of new bogs which have been planted within the last two years, the greater part of which is in Pacific county, Washington, and Clatsop county, Oregon, although there are small bogs being planted all along the coast.

From the best information obtainable it is probable that there is not over 2,500 acres of good cranberry land available in the Pacific Northwest, where all the essential conditions can be found and the bogs constructed at a reasonable expense.

Requirements

Cranberry culture has always proven very profitable when properly managed and where the essential natural conditions are suitable. Most all economic plants show a preference for certain soils and other natural conditions and the cranberry is very exacting in this respect, but when once these conditions are assured there are few fruits that can be more easily and profitably grown. These conditions are well known and easily recognized by any one who will take sufficient interest to secure the literature of the subject and exercise moderately good judgment. Following are the principal requirements:

Soil

The soil should be an acid peat, free from silt or clay and also free from salt. This soil is found in fresh water marshes and is composed entirely of partly decayed vegetation. It should be at least two feet deep and is probably better if deeper. An indication that the soil is suitable is the occurrence of wild cranberries.

Topography Drainage and Climate

The topography of the land should be such that the water can be thoroughly and easily controlled for irrigation, flooding and drainage. The land should be almost but not perfectly level in order that the bogs can be flooded and the water quickly drained off after flooding. It should have a drainage outlet with sufficient fall to thoroughly drain the land to a depth of at least four feet.

The land should be protected from high winds and storms and should have good air drainage, which will greatly aid in protecting the crops from frost.

There are only certain climates in which cranberries will produce profitable returns. The occurrence of wild cranberries is an indication that the climatic conditions are favorable.

Sand

Experience has shown that to secure the highest success and a clean lasting bog and particularly so on the Pacific coast, it is essential that there be an available supply of coarse, clean sand free from silt clay, humus or vegetation or seeds. This sand rètains the heat and moisture, prevents excessive weed growth, aids in frost prevention and in combination with the peat forms an ideal soil for the plants.

Water

Without doubt the most important requirement for a profitable cranberry bog is the water supply. It is the means of insuring a profitable crop each year. It must be fresh water and there must be an abundant supply available at all times. It is used for the purpose of irrigating, flooding for frost protection, flooding for protection from insects and plant diseases and in some localities as protection from winter killing. The water supply may be secured either by gravity or by pumping. Where pumping is resorted to it is sometimes possible to drain the bogs into the source of supply and thus use the same water over several times.

Other requirements to be considered are accessibility and convenience to cities; transportation facilities, both railroad and highway; available labor supply; comfortable and healthy living conditions; storage facilities and markets.

Construction

The success of a cranberry bog will depend largely on the manner in which it is constructed, for after a bog is once

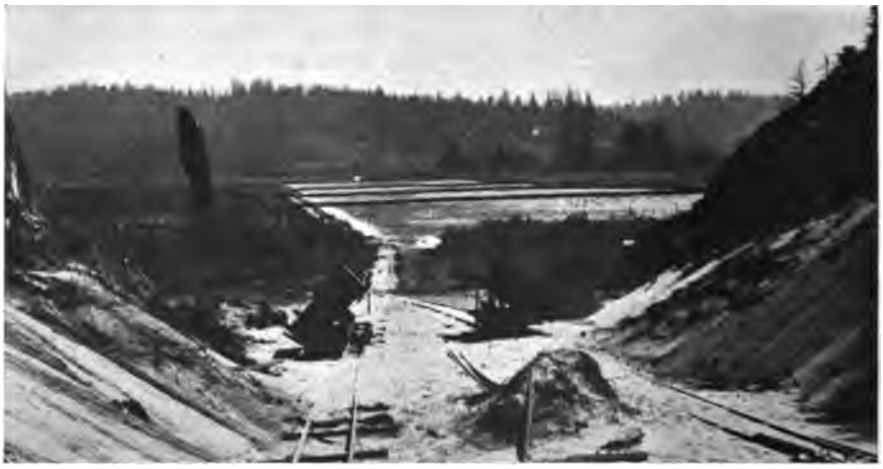

Fig. 1. Part of a Thirty-Acre Tract of O. B. Estes of Astoria, Oregon. In the foreground is the sand pit from which the bog was sanded and also the track and cars used in sanding. A large lake of about 300 acres is at the far end of the bog and is about six feet below the bog. It is intended to water from this lake for irrigation and flooding and to drain all the water back into the lake.

anted, with proper care, it will last for long time. Bogs are known to be 40 ears old. In the last few years there ave been many improvements in the ethods of building the bogs. It has een proven that by using the best methds the profits have been greatly inreased. In Wisconsin on three classes f bogs, semi-wild, semi-clean and clean or f modern construction the average anual yields in barrels per acre were repectively 23, 46 and 94. The methods of onstruction will vary with the conditions.

Clearing and Preparing the Surface

A raw cranberry marsh is most always covered with a growth of trees, brush, or wild grass, which will have to be cleared and removed either by hand or machinery, depending on the character and amount of clearing.

After the land is cleared it is necessary to bring it to a uniform surface and to kill or destroy the surface vegetation. This is frequently done by scalping or removing from three to six or eight inches from the surface of the bog depending on the character of the vegetation. Scalping is done by hand or by cutters or plows drawn by horses or engines. In some cases instead of removing the scalpings they are turned over and left on the bog. Another method is to plow and cultivate the land sufficiently to kill the undesirable vegetation. The scalpings are removed from the bog by wheelbarrows or small cars. In some cases they can be piled and burned. After the bog is scalped it should be graded to a uniform surface.

Sanding

Care should be exercised in sanding the bog. The sand should be put on to a uniform depth of not less than three inches; some growers advise putting it on thicker in deep peat than in shallow peat. There are several methods used in sanding a bog. In some localities where the winters are severe the sand is hauled on to the bog with sleds and spread over the ice and when the ice melts the sand settles uniformly over the bog. Where the sand is located close to the bog it is frequently put on with wheelbarrows and often small cars are used with a portable track. Another method used and probably the cheapest where the conditions are favorable, is to pump the sand on with water and distribute it over the bog through wooden pipe. There is some question if the sand can be put on as clean by pumping as by putting it on dry.

Ditches, Dams, Dikes, Gates, Etc.

Ditches are required to drain the land in order that it can be worked, and later for the purpose of handling the water for irrigating, flooding and drainage. The same ditches can be used for all purposes to a great extent. The size and location of the ditches will depend on the amount of water to be handled. They should be of sufficient size to flood and drain the bogs within a few hours. The ditches should be at least three feet deep and in

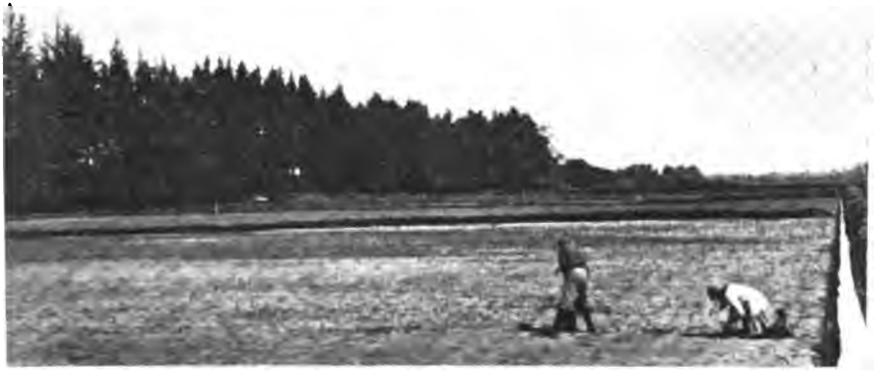

Fig. 2. Planting of Prolifics from Wisconsin on Newly Constructed Bogs. Indicates also method of ditching.

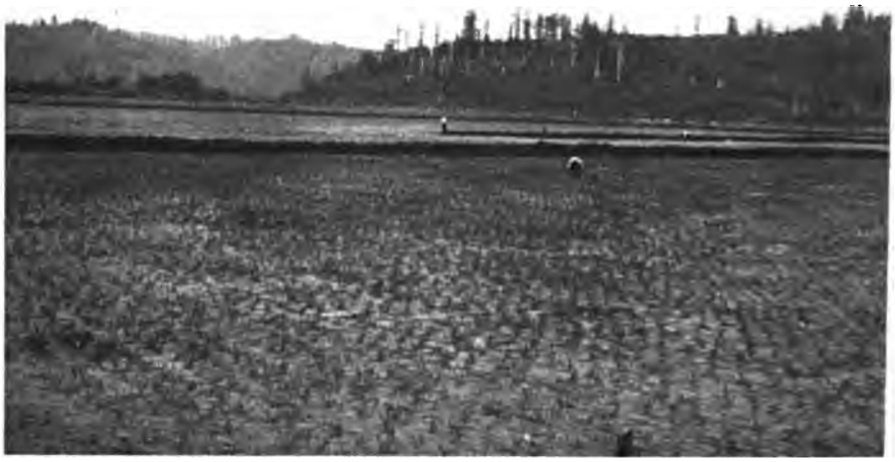

Fig. 3. This Picture Shows a Year-Old Bog. On the near side of the ditch and on the other side is a newly planted bog in which all the ditches have not been dug. This bog belongs to Mr. Schimpff of Astoria and contains ten acres.

some cases deeper. It is sometimes necessary to dig large ditches several miles in length in order to secure drainage. The small ditches are usually dug by hand and some of the larger ditches by small dredges.

Dams and dikes will be necessary along the ditches in order to control the water when flooding. These can be constructed when the ditches are being dug and they are sometimes built with the scalpings from the bog.

In order to control the water for irrigating and drainage it will be necessary to construct gates and flumes in the ditches. The number and location of these will depend on the arrangement of the bogs. They are mostly built of wood, but in some cases the more important may be of concrete or steel pipe.

Water Supply

The water supply may be secured from living streams, storage reservoirs, lakes, or it may be pumped from wells into a reservoir. In some places it is necessary to control large areas of land in order to secure sufficient water. It is sometimes necessary to carry water long distances in canals or ditches. The distributing system should be so arranged that the bogs can be flooded in five or six hours and drained off in two hours. The design of the water system will also depend on whether the water is to be used for flooding or just for irrigating or for both. Where there is sufficient water of the proper character a gravity system will be the best. As there are few places where sufficient water can be secured by gravity it is probable that most bogs will have to depend on pumping plants. The pumps can generally be operated at a very low cost and in most cases will be more economical than a gravity system.

Buildings and Equipment

The buildings required will consist of some dwellings or living quarters for the superintendent, laborers and harvesters; some tool sheds and a packing and storehouse. The storehouse should be so arranged that it can be kept at a uniform temperature and dry and should also be arranged so that it will have good ventilation and that the sunlight will not strike the stored berries. The packing and storehouses should be built and operated by an association of the growers. These buildings are mostly built of wood, but recently the larger companies are building them of concrete or brick.

The machinery and equipment required will consist of some machinery for clearing, scalping and sanding the bogs during the construction period. For the operation of the bogs after they are in bearing about the only equipment required will be spraying outfits; cleaning, grading, packing and sorting machinery; instruments for weather observations, equipment for conveying the berries from the bog to the storehouse and unless the water is secured by gravity, a pumping plant will be required. The greater part of this equipment should be owned and controlled by an association of the growers.

Plants and Planting

Cranberry bogs are established by planting cuttings from old vines. These cuttings should be from eight to ten inches long and are generally planted by forcing the middle of the vine down through the sand into the peat leaving the tow ends of the cuttings sticking up above the surface of the sand. From each of these cuttings runners grow along the surface of the sand and gradually form a thick mat of vines over the entire bog. The vines are generally planted in the spring, but in the Northwest they can be planted during the fall and winter.

There are a great many varieties of vines, but the grower need not consider over a dozen varieties. In selecting the varieties care should be exercised as to whether they are early or late, their keeping qualities, color, size and yield. The principal varieties now grown on this coast are the McFarlan and Early Blacks. The vines now being planted are practically all imported from the East, mostly from Massachusetts. Some of the Massachusetts varieties are Early Black, Howe, Centennial, Bugle, McFarlan, Mathews and Batchelder. Some of the Wisconsin varieties are Prolific, Searles Jumbo, McFarlan, Bennett Jumbo, Metallic Bell, Palmeter and Howe. The only varieties planted from Wisconsin on this coast are the Searles Jumbo, Bennet Jumbo, and Prolific. The vines are planted about ten inches apart and it takes about 700 pounds to the acre.

Developing the Bog

After the bog has been planted it will be at least three years before there is a paying crop and during this time the bog will require considerable attention. The principal work during this time will be to keep the bog free from weeds and to control the irrigation and drainage in order to get the proper growth of vines. It will also be necessary to guard against insects and plant diseases.

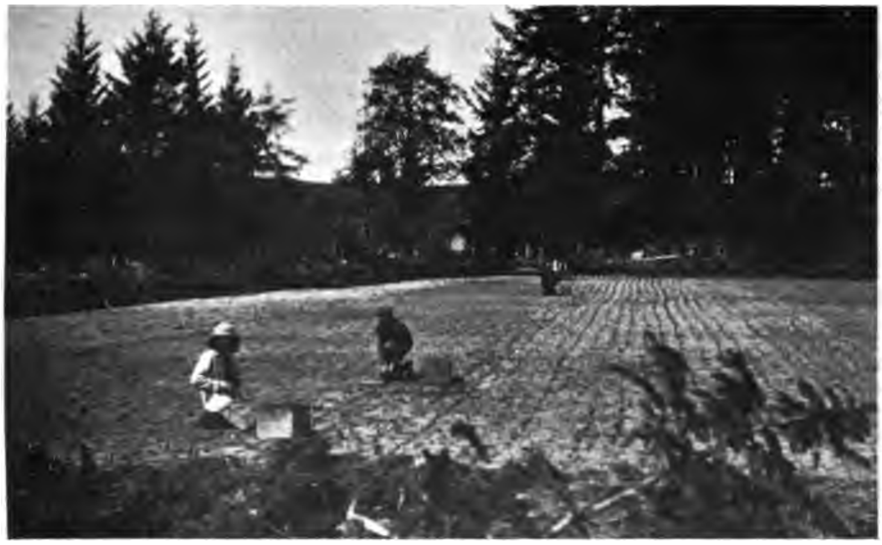

Fig. 4. Children Planting Cranberry Vines.

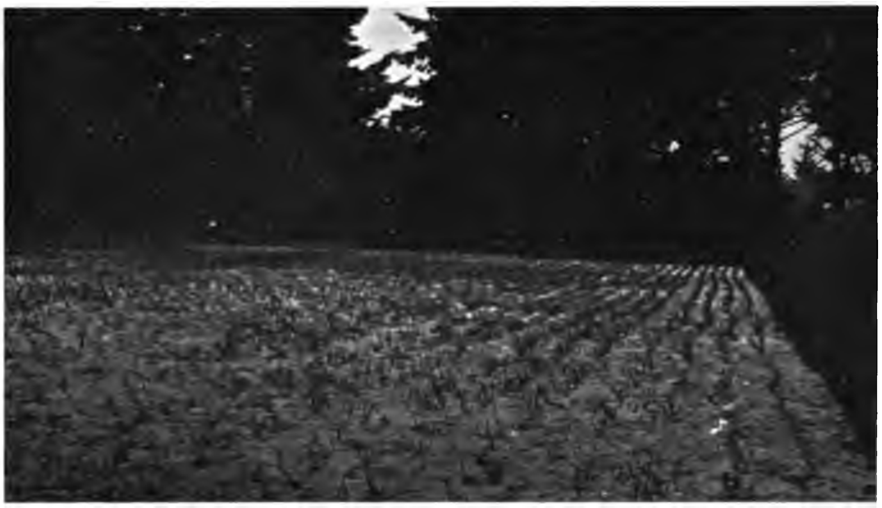

Fig. 5. Vines Planted May, 1912; Picture Taken September, 1912.

Production and Disposal

There will be no cultivation as in many other plants while producing a crop, but there will be some weeding and the ditches and dams will have to be kept clean and there will probably be some spraying required to prevent insects and diseases.

The water and drainage will have to be carefully looked after as the quality and yield of the crop will depend greatly on the control of the water. At times it may be necessary to flood the bogs in order to protect them from frost, insect and plant diseases. It may be found advisable to resand the bogs to a depth of from one-quarter to one-half inch every three or four years. After the crop has been harvasted the vines should be pruned. This keeps the bog in better shape for scooping and also benefits the quality and yield of the berries. Harvesting generally lasts three or four weeks during the later part of August and September. The berries are generally picked before they are fully ripe and allowed to ripen in the storehouse. They are harvested either by hand picking on the younger vines or by scooping on the older bogs.

After the berries are harvested they are taken to the packing houses where they are cleaned, sorted, graded and packed in barrels or boxes and then stored until time for shipment to the dealers.

At present practically all the berries are sold as fresh fruit, but there is an unlimited opportunity to increase the consumption by canning and evaporating them which is done at present to a very limited extent.

The total production of cranberries in the United States is about 500,000 barrels annually which is only about one pint per capita for the United States. It is considered that the cranberry industry is only in its infancy.

Enemies and Hinderances

Like all other organisms the cranberry has its enemies and diseases as well as other hinderances, but by proper care and management these enemies and hinderances can be controlled or prevented. By flooding or spraying the grower can protect his crops from insects and diseases and by flooding can prevent loss from frost. He can also control weed growth. Wind, rain, hail, and extreme heat and cold are elements over which he has no control, but can be avoided to a great extent by choosing a location where the damage from these sources will be very light.

References to Literature

On account of lack of space it has been impossible to go into much detail regarding the various parts of cranberry culture, but by reference to the publications hereafter listed more detailed information can be secured.

Books Published

"Cranberry Culture," by J. J. White.

"Cranberry Culture on a Western Plan," by Augustus G. Gray.

U. S. Department of Agriculture Publications

Farmers Bulletin No. 176, "Cranberry Culture," by L. C. Corbett.

Farmers Bulletin No. 178, "Insects Injurious in Cranberry Culture," by John B. Smith.

Farmers Bulletin No. 221, "Fungus Diseases of the Cranberry," by L. C. Shear.

Farmers Bulletin No. 227, "Experiment Station Work."

Wisconsin Agricultural Experiment Station Bulletins

No. 119, "Reports on Cranberry Investigation."

No. 159, "The Cranberry Insects of Wisconsin," by C. B. Hardenberg.

"Cranberry Bog Construction," by O. G. Malde.

"Cranberry Bog Management," by O. G. Malde.

Also the annual reports of the Wisconsin Experiment Station.

Bulletin No. 86, West Virginia Agricultural Experiment Station, "Cranberries in West Virginia," by L. C. Corbett.

Special Bulletin K of New Jersey Agricultural Experiment Station, "Insects Injuriously Affecting Cranberries," by John B. Smith.

The Annual Reports of the Cape Cod Cranberry Growers Association.

The Annual Reports of the Wisconsin State Cranberry Growers Association.

The Annual Reports of the New Jersey Cranberry Growers Association.

The only periodical devoting space regularly to the cranberry industry is the Wareham Courier, Wareham, Massachusetts. It is published each week.

Bureau of Plant Industry Bulletin No. 193, "Experiments in Blueberry Culture," by Frederick V. Coville, would also be of interest as the blueberry and cranberry are in many ways similar as to natural requirements.

CRANBERRY DISEASES

The fungus and other troubles of cranberries are not so numerous as in the case of some other fruits. The Depart-

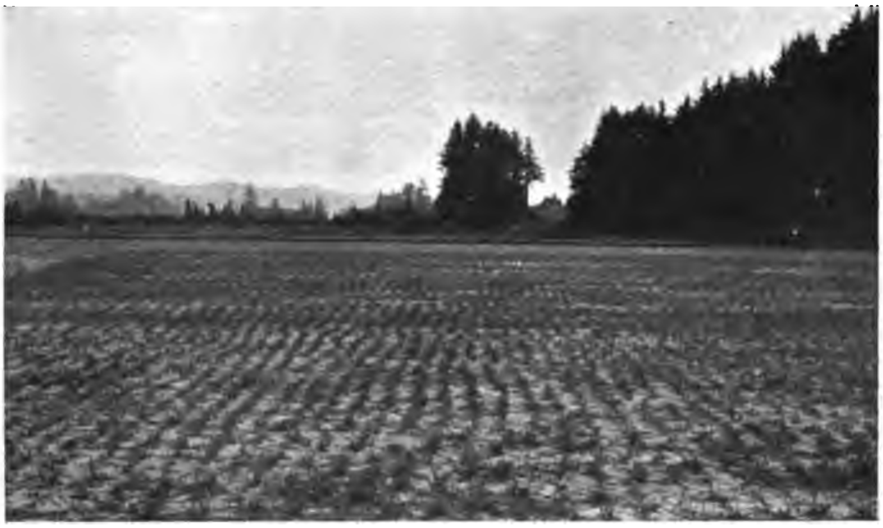

Fig. 6. Part of a Bog Planted May, 1912. Planted with Searles Jumbo vines from Wisconsin. Vines one year old at the time the photo was taken.

ment of Agriculture has conducted some investigation as well as the Wisconsin Experiment Station. The results are embodied in what follows.

Cranberry Anthracnose

Gloeosporium Sp.

Cranberry anthracnose seems to be most common in Massachusetts and New England cranberry bogs. It closely resembles the species so injurious to the apple and other fruits. The appearance of the disease upon the fruits is similar to that of scald and rot, and can only be distinguished certainly by microscopic examination.

Cranberry Blast

Guinardia Sp.

Cranberry blast is a name given to that form of the disease which attacks the very young fruits as soon as the blossoms fall. It causes the fruit to shrivel up, become black, and finally become covered with one of the spore-producing forms of the fungus, which is a species of *Guignardia*, very closely related to the species which produces the black rot of the grape. The spores produced upon these young berries are the probable source of infection of most of the other fruit. This fungus produces two kinds of fruit, or, in other words, passes through two stages of development. The earliest stage produces its spores in small black spherical receptacles. This fruiting form of the fungus is the most abundant, and it is probably from this source that most of the leaves and fruits are infected. The second stage in the development of the fungus is that in which the spores are produced in sacs. These are inclosed in receptacles as in the other stage mentioned.

Blight

This trouble has appeared on Wisconsin bogs as a dying of blossoms and very small fruit just at the time of setting. It is sometimes attributed to hot weather. Investigations at the Wisconsin station, however, seem to disprove this theory. As yet no specific cause has been worked out. If the vines are kept in a vigorous and thrifty condition the trouble seems to be largely avoided.

Cranberry Rot

Cranberry rot has until recently been confused with and attributed to the same cause as the scald. Its effect upon the berry is very similar to that of the scald fungus. It is produced, however, by a quite different species of parasite, though belonging to the same large group known as the "black fungi." In some cases where the fruit is in an advanced stage of the disease, the presence of the fungus is indicated by irregular black blotches just beneath the skin of the diseased portion.

Cranberry Scald

The name "scald" originated as a result of the belief formerly prevalent among cranberry growers that the injury was due to the effect of the hot sun upon the berries when they were wet, thus producing what was regarded as a real scalding of the tissues of the fruit. Fruit which has been overflowed for a half day or more during hot weather may be injured as a result, and the effect in many instances closely resembles that produced by the scald fungus. A microscopic examination of the berries shows at once the difference. In the berry which has been affected by being covered with water no fungous threads or filaments can be found, whereas in the case of the berry attacked by the scald fungus an abundance of such filaments may readily be observed in the pulp of the diseased berry. Only in the rarest instances does the scald fungus fruit on the berries after they have become half grown.

The disease first becomes noticeable as a small light-colored softened spot on the surface of the berry. This spot rapidly increases in circumference and finally envelops the whole fruit. Sometimes the diseased portion shows more or less distinct brownish zones. In other cases the zones are lacking and the whole fruit becomes very soft and has a light watery color. In many instances it is very difficult to tell from the external appearance only whether the disease is due to the scald fungus or the rot fungus.

Remedies and Treatment

Only preventive measures are available at present in combating these diseases. After the parasites have once entered the tissues of the plant they are practically beyond the reach of remedies. Hence, efforts must be devoted to protecting the plants and keeping them in the maximum condition of health and vigor, as in this condition they are most capable of resisting disease.

It has been frequently noticed that the plants on certain cranberry meadows and portions of meadows suffer much more from rot and scald than others. This is no doubt due in great part, in many cases at least, to the soil and water conditions under which the plants are growing. From personal observations and the experiences of growers it is the opinion of the writer that in the majority of cases the control of the water supply is the most important single factor.

Water Supply

Just what the best quantity of water is and the best way to distribute it can only be determined in each case depending upon the nature of the soil, subsoil, contour and drainage of the land. In general it may be said that the water supply should be so controlled as to avoid any great fluctuations in the quantity supplied to the plants during the growing season. The cranberry is by nature a water loving plant, and seems to suffer more frequently from a lack of water than from an excess.

Destruction of Dead Vines

All dead vines and leaves should be destroyed. Frequently small areas of vines die, apparently from the attacks of the cranberry fungi. All such vines should be pulled or cut and collected early in the spring, at least within two weeks after the water has been drawn from the bog, and burned. Vines which have been cut in raking bogs to prepare them for scooping should also be treated in the same manner. Such vines if not destroyed invariably produce the spores of the cranberry fungi in great quantities and are a fertile source of infection for the young leaves and fruit. Little is to be feared from the rotten berries which have reached maturity, as the fungi very rarely produce any spores on such berries.

Disease-Resistant Plants

It is a matter of common observation among growers that some varieties rot or scald worse than others. Hence, in setting new bogs or replanting old ones the most hardy varieties should be used. By giving careful attention to the selection of disease-resistant plants for propagation, a practically immune variety can probably be eventually secured.

Fungicides

The Bordeaux mixture has proved the most efficient of any fungicide used.

Satisfactory results from spraying can be secured only by exercising great care and thoroughness in the preparation and application of the mixture.

Preparation of Bordeaux Mixture

Bordeaux mixture should be prepared as follows:

Copper sulphate (blue vitriol or bluestone)	6 pounds
Unslaked stone lime	4 pounds
Water	50 gallons

Soap for Use with Bordeaux Mixture

To complete the mixture for effective use in treating cranberry diseases, it is necessary to add something to cause it to spread evenly and adhere to the foliage and fruit, whose smooth, glossy surface causes the plain Bordeaux mixture to either collect in drops or run off entirely. Several soaps have been tried for this purpose, of which resin-fish oil soap has proved the best. This is prepared as follows:

Resin	5 pounds
Potash lye, such as is ordinarily sold for washing purposes	1 pound
Fish oil	1 pint
Water	5 gallons

Dissolve the resin with the oil in a large iron kettle. Let this cool somewhat and then add the potash, slowly stirring the mixture at the same time and watching it carefully to avoid its boiling over. Then add a part of the five gallons of water and continue boiling until the mixture will dissolve in cold water. This will require about one hour, when the remainder of the water should be added slowly and the whole thoroughly stirred.

Literature

Farmers' Bulletin No. 221.

Wisconsin Experiment Station Bulletin No. 219.

CRANBERRY PESTS

Comparatively little new work on cranberry insects seems to have been done since that of Professor J. B. Smith, of the New Jersey station, the chief results of which were published by the department of agriculture in 1903. Malde, of the University of Wisconsin, has done some work along the same line. Professor Smith is the main authority for notes on cranberry pests embodied in this work.

Blackhead Cranberry Worm

Eudemis vacciniana Pack.

This is perhaps the best known and most uniformly injurious of all cranberry insects and is locally known as the "vine worm" in Massachusetts and as the "fireworm" in New Jersey. As a larva (worm) it is a deep, rather velvety, green, slender little caterpillar, not over half an inch long when full grown, and with a shining black head and neck. The adult is a small moth or "miller" with narrow, dusty-brown wings that measure less than half an inch when expanded and seem much smaller because they are so slight.

The moths first appear on the bogs in early June, continuing until nearly the end of the month, and again late in July, continuing into August, when they disappear for the season. During the day little is seen of them. In the early evening and until the darkness sets in fully they are on the wing and hover a short distance above the plants.

Before the end of August, they have left, scattered everywhere on the undersides of the leaves, their minute yellow eggs. There they remain throughout the winter, whether the bog be dry or flowed, and the little caterpillars hatch from them in spring. For a day or two the worms nibble on the under surface of the old leaves or may even burrow into them and then make their way to the tip of an upright, where they spin together the edges of the new leaves.

In about three weeks from the date of hatching, the caterpillar is full grown, lines the inside of its shelter more fully and closely with fine silk, and changes to a stubby little yellowish-brown pupa. In a week the transformation is completed and the moth appears about the first of July. The bog at the beginning of July shows very plainly the effects of the insect's attack in brown tips that are everywhere noticeable; and every brown tip at this time means a barren upright.

The second brood which soon appears is more destructive than the first for the reason that they extend their operations farther and the fruit is coming on at that time. They damage the fruit all out of proportion to the food consumed by nibbling here and there on fruits and foliage until the entire bog may have a burnt-over appearance. Hence the term "fire worm," as applied to this species.

There is another brood by the middle of July but the great damage has been done by the second brood.

Yellowhead Cranberry Worm

Teras minuta Rob.

This insect is much more abundant in New Jersey than it is in Massachusetts, and in some localities in the latter state it does not seem to occur as a cranberry feeder at all. It is quite as plentiful on Long Island as it is in New Jersey, and wherever it occurs is apt to be even more injurious than the preceding species.

Life History

The life histories of these two species differ in that, in the case of the yellowhead, the moths hibernate during the winter, come out and lay their eggs during April and May and disappear. The larvae appear a week or ten days later and in feeding spin the leaves together as in the case of the preceding species. The first brood of moths appear in late May or early June. They are bright orange red, while the earlier brood is slate gray. The second lot of eggs hatch in late June, and, early in July, when the cranberries are in full bloom, the larvae are half grown and doing their greatest damage. They pupate about July 15. The pupa is distinguished by a nob on its head. The next brood is not so injurious.

Remedial Measures

Flowing the Bog

The application of insecticides on large bog areas where the plants cover the ground as densely as do the cranberry vines is a task no grower likes to contemplate; and provided he has control of a satisfactory amount of water there is no necessity for it. As against the "yellowhead" (Teras), it will suffice if the water be held on the bogs until the middle of May, or perhaps a little later in cold seasons. This will compel the moths to seek other plants upon which to lay their eggs.

As against the blackhead late holding will not of itself suffice, because the eggs are already on the plants and will, under ordinary circumstances, hatch only under the same conditions that favor the start of vines themselves. But there is a little leeway in favor of the plants and the eggs do hatch under water at a temperature not quite sufficient to start the vines.

Carefully carried out, this measure is often very effective; the warmth favors the development of the embryo within the egg, and when the worm hatches it drowns.

Reflowing

When the supply of water is abundant above the bog area, so that a pond or reservoir may be formed, both the yellow and blackheads may be completely controlled by drawing the water early, waiting until all the eggs have hatched and some of the worms are nearly half grown, and then re-covering the bog with water for 48 hours. This method is so simple and so absolutely effective that the larger growers are adopting it almost universally, and few new bogs are laid out anywhere without considering the matter of reflowage and providing for as good a control of the water as possible. Covering the bogs should begin in the late afternoon and should be completed before next morning, if possible. On a rainy day it may begin at any time, the object being merely to prevent the sun from boiling the young shoots. So drawing off the water should also begin in the early afternoon, and the bog should be practically dry the morning after. Incidentally, this reflowing will rid the bog of numerous other pests and may make a material impression on the girdle worm where that is abundant.

Insecticides

Sometimes it happens that bogs can be neither winter flowed nor reflowed, and the application of insecticides becomes an absolute necessity. Only arsenites are to be relied upon for good results. It follows from what has been said concerning the habits of the worms that when once they have spun up the tips and are feeding in their cases they are practically beyond the reach of our common insecticides; and that is particularly true of the first brood. If there is reason to believe from past experience, or because eggs have been found on the plants, that the early brood will be numerous, spraying must be done just as soon as the vines make a start or not later than the date when the first spun-up tip is seen.

All things considered, the best insecticide for use on cranberry bogs is arsenate of lead.

FIRE WORM. See *Blackhead Cranberry Worm.*

Cranberry Fruit Worm

Mineola vaccinii Riley

Bogs that cannot be reflowed and high and sandy bogs suffer most from this insect.

The adult moth appears on bogs in ordinary seasons about the middle of July, when the berries are setting or have already set.

The moth, with wings expanded, measures about three-fourths of an inch and is of a glistening ash-gray, mottled with white and blackish. It is a shy species, not easily started during the day, and flies with a darting motion for quite long distances. It is not generally recognized, therefore, even by growers who annually lose heavily by it. When at rest the wings are folded close to the body, and on a cranberry stem, where it usually rests head down, it is not readily seen even by an experienced eye.

The eggs are laid on the young berry, preferably in the calyx, just beneath one of the lobes, but they may be on any part of the berry and possibly on the leaves as well. The worms emerge in about five days, and for a day or two feed on the outer side of the berry. Then each worm enters a berry, eats out the seed chamber, and migrates to another. The vacated berry turns red, shrivels up, and eventually drops. In this second berry it becomes half grown, then works out through a large jagged opening and gets into a third berry. By this time the season is pretty well advanced, the fruit is of good size, and, soon after the worm starts feeding, the newly infested berry begins to turn red. To the ordinary observer the fruit is ripening nicely, if early; but the grower knows better and realizes that every such specimen is lost to him. Quite frequently the worms do not get their full growth at picking time, and emerge from the berries after they are harvested. These delayed forms make their way to any crevice or other shelter that they can find and there spin up for the winter rest.

At this time the worm is rather more than half an inch in length, of a bright green color, with a variably marked reddish tinge on the back.

The full-grown caterpillars winter in their silken cocoons, which they make by first rolling in the sand, gluing the particles together with saliva, and then spinning their web inside of the rough casing so formed.

Remedial Measures

Winter flowage is not fatal to these insects, and covering the bogs with water at any time after the winter cocoon has been formed would probably be ineffective. Nevertheless, water-covered bogs are less troubled, and it is probable that the earlier the water is put on in the fall the more effective this practice will be.

Indications are that if a bog can be safely submerged for 48 hours between August 10th and 15th, just before the worms reach their full growth, the great majority will be killed off. Sound berries covered for that length of time will not come to harm if the water can be put on and drawn off rapidly enough to avoid scalding. Fruits not quite so far advanced may be covered for even a longer time without injury. The vines should be completely covered before the sun beats upon them high enough to warm the water, the covering should be sufficiently deep to prevent a scalding effect, and when the water is drawn sunrise should find at least every berry above the water level, that the drying off may be gradual. A cool day would almost insure safety to the berries, an intensely hot one might cause injury, and the nearer maturity the fruit the greater the danger.

If reflowage be not practiced, pick the crop as soon as it is at all practicable, so as to get as many wormy berries off the bog as may be. The worms will emerge in the cranberry house and form their cocoons in cracks and crevices or among rubbish. Give them plenty of shelter in the way of loosely piled slats, boards, or other cover, placed wherever conveniently possible, and any time during the winter clean up thoroughly, so as to reach the hibernating worms. Field mice will eat these worms. Also a liberal use of gasoline in such places under the usual precautions against fire would reach every one of them.

Insecticides are possible only during the two or three days in which the young worm feeds on the outside of the berry, and the only material that offers any chance of good results is arsenate of lead. One spraying per week for three, or preferably four, weeks offers a fair chance of success by killing off the berry worms before they get into the berry.

On bogs that cannot be flowed the arsenate of lead, aided by early picking, will probably reduce the amount of injury materially; but on such bogs the development of the moths may occur earlier and the grower must rely more upon the stage of growth, or, better, the appearance of the moths themselves on the bog, than upon any absolute dates.

Cranberry Girdler

Crambus hortuellus Hbn.

This species, more commonly known as the "girdle worm," is found abundantly in all the cranberry districts, but it is seriously injurious in Massachusetts only. The larvae, which are slender, grayish caterpillars, with shining, light chestnut-brown heads, and yellowish thoracic shields, pass the winter in a torpid condition within a silken tube or cocoon, which resists the entrance of water. In New Jersey the adults are found in May; in Massachusetts they do not fly until July. The change to the pupa takes place in the tube or cocoon made in the previous fall, and on Cape Cod at the latter part of May or in early June. The adult is a pretty little creature, with forewings expanding about three-fifths of an inch, and is one of the long-snouted moths, the palpi or mouth feelers projecting well beyond the head. The forewings are rather narrow and very pale straw-yellow in color. The hindwings are much broader and of a uniform silvery gray. When the moth is at rest the wings are so closely wrapped around the body that it looks like a narrow whitish cylinder about three-quarters of an inch in length.

The young worm is very active and strong, and at once begins the construction of the silken tube, re-enforced by bits of vegetation, in which it lives. It works about the running portion of the plants extending along the surface of the sand in the stratum of fallen leaves which always cover an old cranberry bog and from which the delicate clusters of new rootlets take their rise. Everywhere over an infested area, but especially along its borders, these worms can be found in filmy silken galleries following the prostrate stems of runners, into the surface of which they eat their way, destroying the vital part of the plant and, especially next to the base of the runners, deeply girdling the stem. They grow rather slowly, and not until November do they make their coarse cocoon of mingled sand and silk that serves as winter quarters.

An infested bog is rarely affected over its entire extent. Small areas varying from a few feet in diameter to half an acre or more are found here and there, and sometimes a little patch only a foot or two across will remain for two or three years in succession without becoming enlarged, but rather it will become closed up by runners from the adjacent healthy vines.

Remedial Measures

It is quite obvious that insecticides are not available here, because of the concealed feeding habit, and that resort must be had to more direct methods. But the insect does not make this cocoon until November, and a submergence of five days immediately after the picking is completed destroys a great many. The suggestion is therefore made that, immediately after the fruit is off, infested bogs be flowed and be kept covered for at least a week, and better two weeks. While the ripening fruit is on, any water covering kept on over 24 hours would be apt to do material injury.

An additional suggestion is that the actually infested area be completely burned off as soon as its extent can be determined. For this burning a gasoline torch may be employed, and the heat thus applied directly to the point where it will be most effective. The burned-over area can be immediately reset and the actual amount of injury limited to a minimum.

Cranberry Katydid

Scudderia texensis Sauss.

One of the most destructive insects on the New Jersey bogs is a species of katydid, though its injuries, as a rule are charged to grasshoppers in general.

The injury is chiefly caused by the feeding habits of the adult of one species of katydid which chews into the berries when half to full grown, rejects the pulp, and eats the seeds. The injured berries wilt, shrivel, and die; but when they have just been left by the katydids, the common, shorthorned grasshoppers feed on the exposed pulp and, being detected in this, are quite generally charged with having caused the entire trouble. One katydid may eat out several berries at one sitting, and when the insects are at all abundant the percentage of fruit destroyed is very large; on some bogs the amount reaches almost or quite one-half the entire crop.

The katydids when mature are green, grasshopper-like insects, with very long antennae, or feelers, and long slender hind legs.

The eggs are laid chiefly in two kinds of grasses, locally known as "deer grass" and "double-seeded millet." Occasionally eggs are laid on other grasses or plants, but never on cranberry leaves.

Remedial Measures

The character of the remedy to be adopted follows from the egg-laying habits of the species. Allow none of the host grasses to maintain themselves on the bogs and burn over the dams during the winter while the bogs are flowed. From the fact that the very young katydids are never found on flowed bogs except at the edges joining the upland or at the base of the dams, it may be fairly inferred that the eggs do not survive the winter when kept completely submerged, so that destruction of the grasses above the water line might answer. It would be safer, however, to have the grasses out; they have no place on the bogs anyway.

For burning the grasses and other host plants on the dams some one of the gasoline torches now on the market may be used. They give a very intense heat and lick up leaves and plants with extreme rapidity. As they can be used against the wind or while the plants are somewhat damp there is practically no danger that the fire will get away, and when the ground is frozen, the covering of leaves and stalks is burned so rapidly that no heat gets to the roots.

Grasshoppers and Crickets

Numerous short-horned and long-horned grasshoppers may be found on and about the bogs, and more or less injury is charged to them. As to the common gray or brown short-horned grasshoppers the charge is believed to be practically unfounded. They do sometimes finish up berries that have been opened by the katydids; but direct evidence is lacking that they would or even could get into a sound berry. Nor do they occur in any numbers on clean, well-kept bogs, free from grass and overgrown edges or dams. They belong naturally in the grassy undergrowth along the margins, and simply run over when there is an easy opportunity.

It is rather otherwise with some of the long-horned, green, meadow grasshoppers, which on grassy, reedy, or sedgy bogs are sometimes present in immense numbers. All of these are fond of seeds, and while the smaller species cannot get into a half or full grown berry, the larger species can, and so they join the katydids in their destructive work, but in comparison do little injury.

Most of them have a long, flat ovipositor, straight or slightly curved, and they lay their eggs in the stems of the sedges, rushes, and larger grasses found on the bogs. None of these species can cut into leaves. Their eggs are long, slender, nearly cylindrical, and often just a little curved. They are laid in series of anywhere from three to eight, one above the other, the number of eggs in any series depending upon the length of the ovipositor in the species.

Where bogs are very full of these little species, a large proportion of the grasses and sedgy plants will be found bearing eggs, and these eggs are so well protected that they survive the winter though they be completely submerged. Accordingly, in early June thousands of the little meadow grasshoppers are found just hatched and under such conditions that they could not possibly have come on from the outside.

Remedial Measures

The only way to keep these species off the bogs is to keep down the grasses. They are not naturally feeders upon the cranberry plant, and exact so small a toll that the actual loss is less than the probable cost of getting rid of them. If the grasses, etc., cannot be readily taken from the bogs, they might be mowed, after picking, above the vine level. This would cut off the parts bearing the eggs, and as the loose grass would float when the water is put on, the eggs would either be carried to the edges or would decay with the vegetation containing them.

Crickets also occur in greater or less numbers on most bogs, and growers are by no means agreed whether they cause injury or not. That they will eat berries on the ground, especially under cranberry crates, is certain; but it is not proved that they ever go upon a vine to feed upon a berry attached to it. The species lay their eggs in sandy soil, and never in wet or mud land; so, as a matter of fact, no field crickets can really propagate on the bogs. But they get into the dams, and oviposit in warm sandy places, so that the young may hatch early in the spring and find their way to the moist, warm places in which they delight. Their range of food seems to be wide, and there is almost nothing they will not eat under favorable conditions; but they live on the ground and rarely get out of the shelter of the vines or upon them.

If it be deemed desirable the crickets can be kept off the bogs almost entirely by broad, clean, marginal ditches maintained at least partly full of water. The crickets rarely if ever fly, and, while they are good swimmers, do not ordinarily attempt to cross any ditch six feet wide.

A flowing just after picking would destroy most of the grasshopper and cricket tribe that then occur in their greatest number.

MEASURING WORM. See *Cranberry Span Worm.*

Cranberry Span Worm

Oleora pampinaria Gn.

In some sections of Cape Cod certain "span," "inch," or "measuring" worms occasionally become injuriously abundant and the most destructive of these is the species above named. The color of the parent moth is pale ash gray, sprinkled with black, and both wings are crossed diagonally by black lines and shades. The worms first appear on the bogs in June and become fully grown by the end of that month or early in July. They are then rather more than an inch long; slender, smooth, livid gray caterpillars with deeply indented head and long, pointed anal plate.

When full grown they bury themselves in the ground and pupate. The moths emerge a few days later. The second brood comes on in early August and pupates before the tenth. The moths appear late in August and September.

There seems to be no regularity about the appearance of these insects. Some years they do not appear at all. In others they appear in great numbers and occasionally in armies.

Remedial Measures

Being an open feeder upon the foliage, this span worm is susceptible to arsenical poisoning, and unless the bogs can be rapidly reflowed and as rapidly laid dry, spraying or dusting are the only alternatives. Where the worms are noticed when they first start, spraying the foliage just ahead of them may answer all purposes, and indeed this poisoning of their line of advance should always be done before treating the parts already infested. Either Paris green or arsenate of lead may be applied.

Cranberry Tip Worm

Oecidomyia oxycoccana Johns

This is a minute orange-red or yellowish grub about one-sixteenth of an inch in length, found in the growing shoots, whether uprights or runners. It appears on the vines soon after they make a start, and the first indication of its presence is when the small leaves of the tip cease to unfold and become bunched into a compact, bulb-like mass. When this mass is opened, from one to five, and usually two or three, of the little grubs will be found at the very heart of the growing tip, feeding upon the juices and completely checking growth. If it is a runner that is attacked, it is destroyed; if a fruit-bearing upright, the flower buds come out below the infested tip and no harm is done to the crop. But the insects continue to appear on the bogs at intervals throughout the season, and the danger is that the late-tipped uprights will form no fruit buds for the next year.

The adult is a minute, two-winged fly or midge whose wings when expanded measure less than an eighth of an inch from tip to tip. The male is quite uniformly yellowish-gray and inconspicuous, but the female has the abdomen deep red, the upper surface of the body gray, the sides yellowish, the head and eyes black. She also has a slender, extensile tip to the abdomen, by means of which the minute white eggs are laid in the very heart of the bud.

Remedial Measures

Strictly speaking, no direct remedial measures are known. It is not known positively how the insect passes the winter; hence control can not be attempted at that season. The worm never comes within reach of our ordinary insecticides, and therefore direct attack is not possible. Since the loss of the tips attacked in spring does not injure the crop of that year, the effort must be to keep the vines in such vigor that they will set fruit buds on laterals and at leaf axils when the direct tip has been lost.

This insect is not confined to the cranberry, and in fact breeds much more abundantly on loose strife (*Lysimacha*) and on some of the heaths. Therefore, where the species is troublesome, those plants should be kept down on the dams and other bog surroundings.

VINE WORM. See *Yellowhead Cranberry Worm.*

Cress

The word cress, when applied to plants, refers to any one of several species mostly of the mustard family *Cruciferae*. It has generally a pungent taste and is used in salads.

The common cresses are the English water cress; the American water cress; common garden cress and the Indian cress. The water cress is an aquatic plant, with long stems, which readily take root in water or very moist soil. It is therefore generally grown along the edges of streams, ponds, ditches, or other places, where it grows partly in the water and partly out. But it may be cultivated by the digging of trenches or small ditches, where the water may be turned on at pleasure.

GRANVILLE LOWTHER

CRESS PESTS

Water Cress Leaf Beetle

Phaedon aeruginosa Suffr.

Attacks the under side of the leaves and the stems, eating off the cuticle.

The beetles are less than an eighth of an inch long and "shiny, bronzy black." Both the adult and larva are injurious.

They probably range from Massachusetts to West Virginia.

Growing the cress in running water which carries the bugs away, or flooding for the same purpose are the best remedies thus far discovered.

Literature

Bureau of Entomology Bulletin 66.

Water Cress Sowbug

Mancasellus brachyurus Harger

This pest has been troublesome in Virginia, West Virginia, and Pennsylvania, where cress is grown commercially.

This creature is not a bug but belongs to the same order as the crayfish. It differs somewhat in appearance from the common dooryard sowbug though similar in general features. The water cress sowbug is "decidedly shrimplike" in appearance, gray in color and when full grown about a half inch long.

The only method of control which seems to have worked successfully so far is that of special construction of the cress beds.

The beds are constructed sixteen feet wide with a general slope of about three inches to the 100 feet and graded toward the center, through which, running lengthwise of the bed, is placed a square trough made of three ten inch boards. When it is desired to get rid of the bugs the water is shut off from the bed and drained out through this central trough. The bugs follow the receding water and so are caught in the trough. After the water is well out of the trough the bugs are killed with bluestone. The water is kept off the bed for twenty-four hours to kill the bugs which remain in the cress.

Literature

Bureau of Entomology Bulletin 66.

CROPPING, PREPARATORY. See *Preparation of Ground* under *Apple Orchard.*

Cucumbers

Cucumis Sativus

Long Green Cucumber.

The cucumber is a well known fruit, grown in all parts of the civilized world, and cultivated from very early times. It is supposed to have been cultivated in the days of Moses, and mentioned in Numbers XI: 5. Alphonso de Condolle affirms that the cucumber was cultivated in India 3,000 years ago. The plant is an annual trailing vine, with stalked hairy leaves, and tendrils by means of which the plant can be trained to supports. There are a large number of varieties which may be classified under two general heads as follows:

First. Forcing or hot house varieties.

Second. Outdoor or field varieties.

The "forcing varieties," are started in hot houses or hot beds, and later may be transplanted to the open air, or the growth continued under glass for winter use.

The outdoor varieties are planted in hills, about six feet apart, six or eight seeds to the hill and then thinned to two or three after they are fairly started, and the strongest plants left for further development. When the vines are about two feet long, some growers pinch off the tops so that the vine will put out lateral shoots and bear a heavier crop. The flowers are pollenized by insects, and the varieties will mix by interpollination.

Soil Best Adapted

The cucumber will do fairly well on almost any soil that will grow corn, wheat or oats; but it does best on deep, rich loam. When the ground is warm and well prepared, it may be planted as early in the spring as the time when danger of frost is past; and the seed covered about one inch deep. There are no special directions necessary; for the cucumber is so common that almost every one knows something of its habits of growth.

Picking

The time for picking cucumbers depends on the uses to which they are to be applied. If grown for pickles, they are picked when about three inches long. The whole area should be gone over every second day and all of the required size carefully removed from the vines, cutting the stem about a quarter to half an inch from the cucumber. Care should be exercised to see that the pickers do not bruise the vines by tramping upon them, or the crop will be injured.

If cucumbers are meant for table use, they may be allowed to grow to considerable size, say six inches in length, provided that they should not be allowed to approach too nearly the ripening period when the surface skin begins to turn yellow.

Certain vines may be selected to produce seed, in which case they should not be disturbed by the picking process, except to train the vine to produce the largest and best specimens. As soon as the seed is ripened the plants begin to die.

Varieties

If cucumbers are planted for pickles, the varieties producing the largest number of small fruits, rather than a few large ones is preferable. For this purpose the variety known as the Boston Pickling is highly recommended. For general home use the White Spine is good. Other varieties are the Cumberland, Thorburn and Fordhook Pickling.

GRANVILLE LOWTHER

Cucumbers in the South

W. P. WILLIAMS

Cucumbers can be made a very profitable crop in all sections where they can be raised early, and shipped to Northern markets.

After the land has been prepared, the best way to fit it for the crop is to plow out furrows with a single shovel cultivator, or a bull tongue, and in this furrow put the fertilizer, and with a narrow cultivator thoroughly mix this with the soil. Then with a sweep or cultivator, level the soil into this furrow, and then drill in the seed.

The rows are made five or six feet apart, and after the plants are up, they are thinned to about one foot in a row. The seed are sown in the southern part of the Gulf states from March 1st to the 15th, some risk being taken at this time as there are occasional killing frosts this late. Providing the crop is not injured by frost, a few days gain on the market makes a considerable addition to the profits obtained.

Cultivation is given the cucumber similar to that of other crops. Frequent but shallow cultivation is practiced, care being taken not to disturb the vines more than necessary. The soil is ridged slightly to the row so as to allow surface water to run off quickly. Cucumbers require a quick steady growth and thus the land must be sandy so as to give the best action for fertilizers.

The best fertilizer found in this section consists of 7-4-8 goods, using about 700 to 1,000 pounds per acre, and made up as follows:

	lbs.
Acid Phosphate, 16 per cent	395
Cotton Seed Meal	286
Nitrate of Soda	125
Muriate of Potash	194
	1,000

The nitrogen should be obtained from some compound where it is easily available, as in dried blood. The above formula is put under the plant, and when the latter has developed the fourth leaf a top dressing of about 75 lbs. of nitrate of soda is given, and about the time the blossoms fall, another dressing of 75 lbs. is applied.

The cucumbers are picked when about eight inches long, and packed in hampers or crates. The harvesting in this section begins about June 1st to the 15th, varying a little with the season. The hampers or crates are put in refrigerator cars, there being about 300 to 500 per car. These cars are shipped to various northern markets, as Chicago, Cincinnati, St. Louis and Detroit.

The varieties most commonly grown are Davis Perfect, Long Green and Klondike. The market requires a long slender cucumber, with very small and few seeds, and the above varieties produce cucumbers of this description.

Yields run from 250 to 400 hampers per acre, and prices from 40c to $1.00 per hamper. The outlook for this crop is very promising where a person has the right kind of soil, and sufficient cooperation among his neighbors that all may combine to ship in car load lots. A market must be made, and when a place has become known as a shipping point, buyers will visit that point.

CUCUMBER DISEASES

For *Diseases of Cucumber* other than those listed here, see *Cantaloup, Squash and related plants.*

Anthracnose

Colletotrichum sp.

Anthracnose occurs on the leaves and stems of cucumbers and muskmelons, and on the leaves, stems, and fruits of watermelons. It also attacks other cucurbits. It is common and sometimes injurious.

Appearance

Circular dead spots from one-fourth to one-half inch in diameter are formed on the leaves. On the stems anthracnose causes elongated, discolored, and shrunken areas, which finally lead to the death of the branch. Watermelon fruits are often badly spotted by this disease, and much injury is done to the vines.

Cause

Anthracnose is due to a fungus which is related to the fungi causing anthracnose in grapes, raspberries, cotton, and beans, and the bitter rot of the apple. It is spread freely by the fruiting bodies, which are produced in abundance in the spots on the leaves and fruit. The destruction of such vines, together with rotation of crops, is recommended as a means of prevention.

BLIGHT. See *Downy Mildew*, this section.

Cucumber Rot

Cucumbers in Florida have been troubled with a disease which attacks both leaves and fruit. The plants may be attacked when very young. There appear on the leaves irregular water-soaked spots. The leaf becomes dwarfed and misshapen if the disease strikes it when young. If the sun is hot during the day the spots dry up, leaving a brown area, which will fall out. Quite often the infection starts along the edges of the leaves. The veins become affected, and it appears as if the disease follows the veins. Early in the morning, if one should examine the under side of the leaves, he would find underneath each spot a drop of bacterial ooze. Later in the day this dries, giving the appearance of a white precipitate. The spot on the cucumber fruit is small, about two millimeters in diameter. At first it is a transparent area, then in the center there appears a small white spot which is the dried bacterial ooze on the surface. If one should cut through an early spot, he would find only a water-soaked area. Later this area turns brown. This brown area spreads along the vascular bundles in the cucumber fruit. Three days later the whole cucumber is soft.

The disease is spread over the entire cucumber-growing district of Florida. Much loss is sustained while the cucumber is on its way to market. The reports show that while the cucumbers are on the way to market, which takes four to five days, they become soft.

Remove affected plants from the field and spray with Bordeaux mixture, thoroughly, beginning when the plants have but three or four leaves.

O. F. BURGER,
Florida Experiment Station.

CUCUMBER SCAB. See *Spot*, this section.

Damping Off

This is a frequent trouble upon greenhouse cucumbers. It is serious often where plantings are made following lettuce attacked by rosette. The fungus in that case is the same as lettuce-rosette (*Rhizoctonia*) or lettuce drop (*Botrytis*). There is a strictly damping-off fungus (*Pythium De Baryanum* Hesse) that is sometimes troublesome. The Botrytis named at times attacks pruned parts of cucumber plants, also extending its attacks to the blossom end of young fruits. The results of Rhizoctonia on greenhouse cucumbers have been curious owing to attacks on the smaller root branches or rootlets. The growth of the vines is at times checked, accompanied by coloring of the leaves and reduced fruitfulness. Some growers have given the name "leaf-curl" to this phenomenon but it is strictly the effect of the fungus named. It has been found necessary in soil treatments where cucumbers follow affected lettuce to increase the strength of formalin drench to 4 or 5 pounds per 50 gallons of water.

A. D. SELBY,
Wooster, Ohio.

Downy Mildew

Pseudoperonospora cubensis
(B. & C.) Rost.

Downy mildew, the most destructive of all cucurbit diseases, is especially injurious to cucumbers, but also attacks melons, squashes, pumpkins, gourds, and other related vines.

Appearance

The first indication of downy mildew in the field is a yellowing of the older leaves in the center of the plant. Faintly defined angular spots bordered by the veins will then be detected. These become more distinct, and if the weather is moist an obscure violet coating of the spores may be noticed on the under side of the spots. The disease progresses from the center of the hill outward, the young leaves at the tips of the branches living longest. It spreads slowly in bright weather, but under the more favorable conditions afforded by cloudy, humid weather it often develops with the greatest rapidity, so that the fields quickly become as if scorched by fire.

Downy mildew has been known in this country since 1889, and in various years has caused serious loss, especially to the pickle industry on Long Island and in Ohio and other states. It is also destructive to cucumbers in greenhouses.

Cause

Downy mildew is caused by a parasitic fungus closely related to the destructive downy mildews of grape, onion, etc., and to the late blight of potato. So far as known, it is spread entirely by its conidia, or summer spores, produced on the lower surface of diseased leaves. These are blown about by the wind, but are very thin-walled, delicate bodies, which perish quickly when dried.

Conditions Favoring Development

The disease lives through the winter in Florida and probably spreads northward each summer. There is also good evidence that it lives over in greenhouses, which may later become the centers of local epidemics.

Spray frequently with half strength Bordeaux mixture, coating both sides of the leaves.

References

Farmers' Bulletin 231.
Connecticut Station Bulletin 56.
Ohio Station Bulletin 214.

EELWORM. See *Nematode*, this section.

LEAF BLIGHT. See *Cantaloup Diseases.*

Leaf Mould

Not important. Yields to same treatment as downy mildew.

Leaf Spot Diseases

Aside from anthracnose, downy mildew, and leaf blight there are a number of other leaf spot diseases hardly distinguishable from the above, all of which yield to the Bordeaux treatment.

Mosaic Disease

This disease of greenhouse cucumbers is analogous in character to the mosaic diseases of tobacco and tomatoes and to the yellows of the peach. It is due to an oxidizing ferment in the leaves and is transmitted like the tobacco mosaic disease, by touching first diseased and then healthy plants. The fruitfulness of these variegated yellow plants is very low and it is best at all times upon the appearance of the disease to remove the diseased plants and destroy them.

A. D. SELBY

Nematodes or Eelworms

Heterodera radicicola (Greef.) Mull.

These minute parasitic worms are often very destructive upon cucumbers under glass. The greatest injury may occur on the seedling plants, but plants of all ages are destroyed by the parasitic worms. Their presence may be known by the small, bead-like enlargements produced upon the roots or rootlets. No remedy has been discovered that is effective with plants once attacked by eelworms. The time to prevent this trouble is in the selection or preparation or treatment of the soil for greenhouse benches. Indeed the nematodes seem to be present in old sod, and to some extent in decaying vegetable matter generally. An effective remedy against eelworms consists in steaming and so treating the soil that the parasites will be destroyed. For this procedure see Ohio Bulletin 73. Also

Massachusetts Experiment Station Bulletin 55. In thus handling the soil due time must be given for draining and drying.

A. D. SELBY

Powdery Mildew

Erysiphe cichoracearum DC.

Frequent in hothouses, but not troublesome elsewhere. Selby recommends a dilute copper sulphate solution.

Reference

Ohio Experiment Station Bulletin 214.

ROOT ROT. See *Damping Off*, this section.

Spot of Cucumber Fruit or Cucumber Scab

Cladosporium cucumerium Ell & Arth.

Yields to same treatment as downy mildew.

Wilt, Bacterial Wilt

Bacillus tracheiphillus

Scattered plants wilt gradually without evidence of injury. The sap tubes are filled with a milky, stringy mass of bacteria instead of watery sap. Insects are instrumental in spreading the disease.

Spray with Bordeaux as an insect repellent. Cut out and destroy all affected plants. Practice rotation.

References

Pennsylvania Experiment Station Bulletin 110.

Farmers' Bulletin 231.

South Carolina Experiment Station Bulletin 141.

CUCUMBER PESTS

For cucumber pests other than those listed here, see *Cantaloup*, *Squash*, and related plants.

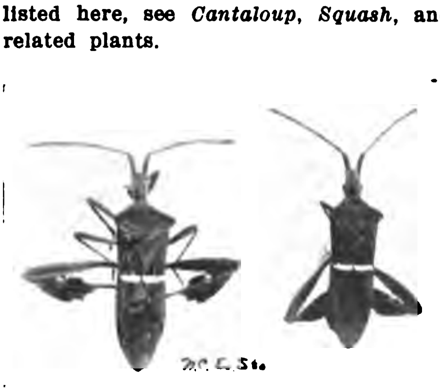

Fig. 1. Banded Leaf-Footed Plant Bug.

Banded Leaf-Footed Plant Bug

Leptoglossus phyllopus, Say

This conspicuous plant bug is a sucking insect belonging to the same family as the squash bug, and is capable of inflicting similar injury to cucurbits.

This species is distributed over all the Gulf states and many of the neighboring states. In North Carolina it is quite abundant in some sections.

Remedies

In case these bugs should become abundant, they might be controlled by hand picking during the early morning hours or about sundown, for at such times they are less active than during the heat of the day. It has been suggested that the young nymphs may be killed with kerosene emulsion.

The yellow thistle (*Carduus spinossissimus*) is their normal food plant, which suggests the advisability of keeping these plants cut down around gardens or fields where cucurbits are grown, or leaving only a few plants to serve as traps on which the bugs may be killed by spraying or hand picking.

Cucumber Flea Beetle

Epitrix cucumeris, Harr.

A small, black, oval-shaped, jumping beetle, about one-twelfth inch in length, sometimes causes quite severe injury by eating holes in the foliage of young cucumbers and other cucurbits. The larva of this species is a leaf miner, attacking the same plants, but seldom causing much damage.

Remedies

Wire screens or other mechanical covers, poison and repellent sprays, dry poison applications, clean culture are equally effective against flea beetles.

Cutworms

Various Species

These may be destroyed by the use of poison bait made by mixing bran (40 parts) with Paris green (one part) moistened to make a soft mash and then sweetened with molasses.

Distribute around the hills about sundown.

Keep the chickens out when this method is employed.

Hop Flea Beetle. See under *Potato Pests.*

Melon Aphis. See *Aphids.*

Melon Worm

Diaphania hyalinata Linn

This pest occurs in large numbers in Florida, Georgia and North Carolina.

Description and Habits

Parent Moths

Melon worm moths are beautiful creatures, which may often be seen flying about cucurbit fields during the late fall months. They have wings of a pearly white color, bordered with brownish black (Fig. 1). The abdomen is also pearly white, tinged with brown at the caudal end, which terminates in a large movable brush of elongated yellow and dark-brown scales. Nearly all the underside of the body, including the legs, is of the same color as the wings. The wings expand one inch, or a little more. The moths, although shy and rapid fliers, are frequently seen during the daytime.

Eggs

These are pearly white in color, very small in size, and are laid in groups of from two to six or more on the stems, leaves and buds. They hatch in about four days in warm weather.

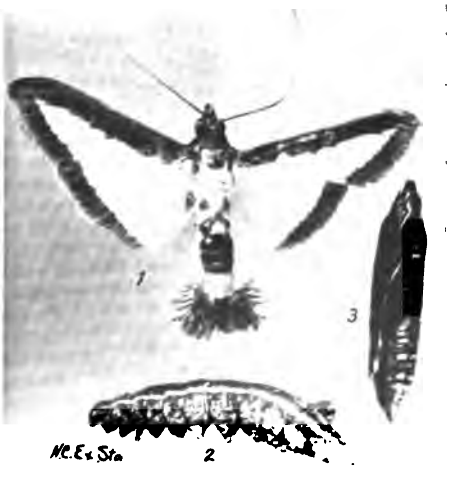

Fig. 1. Melon Worm. 1, adult; 2, larva; 3, pupa.

Larvae

Just hatched larvae are about a twenty-fifth of an inch long, with a pale brown head, and body of a pale yellow color, with no distinct markings. At about three days of age the skin is molted for the first time, and then the body shows two faint longitudinal sub-dorsal white stripes, which become more prominent as the larvae develop. By these two white stripes melon worms (Fig. 1) may be readily distinguished until they are nearly grown, when the white stripes disappear.

These worms often feed for their entire lifetime on the foliage, remaining on the underside partially concealed by thin silken webs. They also feed in the terminal bud clusters, and bore into melons and squash like the pickle worm. The habit of feeding on the foliage makes it profitable to use poison sprays as a remedy.

Cocoons and Pupae

Melon worms spin thin silken cocoons in the folded edge of some leaf, like the pickle worms, but differ from the latter in being inclined to select a green leaf rather than a dying one. When the food plants are nearly defoliated the worms crawl to nearby weeds or grass, and there spin cocoons and pupate.

Remedial Measures

Because of feeding freely on the foliage, melon worms may be poisoned with arsenical sprays, and the additional methods suggested for controlling pickle worms. See *Pickle Worm*, this section.

Supplementing the poisoning methods the complete removal and destruction of badly infested trap plants, badly infested fruit of all cucurbits, and remnants of infested crops, together with the practice of deep plowing and rotation should suffice to prevent serious damage from melon worms. R. I. Smith

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N. C. Exp. Sta.

Northern Leaf-Footed Plant Bug

Leptoglossus oppositus Say.

This species has been reported as damaging melons in Maryland and the District of Columbia, and occurs in many

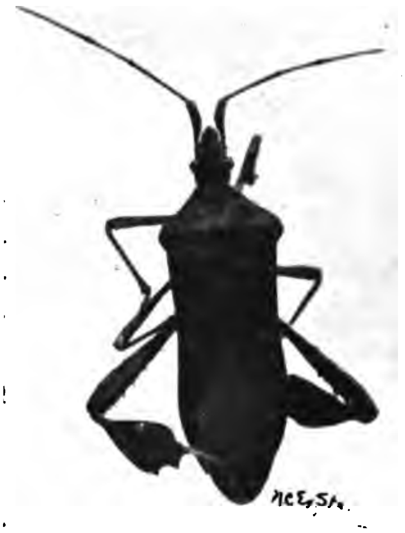

Fig. 1. Northern Leaf-Footed Plant Bug.

of the Southern states, including North Carolina.

Hand picking as for other plant bugs and destruction of young nymphs by kerosene emulsions are the remedies suggested.

Pickle Worm

Margaronia nitidalis Cramer

Description

The parent of the pickle worm is a night flying moth of rather distinctive appearance (Fig. 1). The general color, is yellowish brown. The front wings bear a yellowish, semi-hyaline spot near the center, and the hindwings have the inner two-thirds of the same appearance. The abdomen terminates in a large movable brush composed of numerous elongated scales. In size the moths have a wing expanse of a little over one inch, while the body averages about five-eighths of an inch from the tip of the head to the end of the brush. The shy, retiring habits of these moths prevent their being often observed, for they seldom fly in the daytime, unless disturbed, and then quickly attempt to hide. In this respect they differ from the melon worm moths, which are often seen flying about cucurbit fields during August or September.

Eggs

Freshly laid eggs are white, but soon turn yellowish, as the larvae inside develop. They may be laid singly, but more commonly in clusters of from three to eight, on bloom buds, leaf stalks, or leaves, and are usually attached to the plant hairs in such a manner that the egg mass seems to be pierced by the hair. The eggs hatch in warm weather in about four days.

Larvae

Very young larvae are uniformly yellowish white, but after a few days the body segments show transverse rows of brown spots, which become more prominent and nearly black in color before the fourth molt is passed (Fig. 1). Larvae molt four times before attaining full growth, and their distinctive marking, previous to the fourth molt, enables one to separate them readily from the related species called the melon worm. After the fourth molt pickle worms become greatly changed in appearance by practically losing the transverse blackish spots. Pickle worms feed in bud clusters, blooms or fruit and often in the vines, but seldom feed, like melon worms, on the foliage.

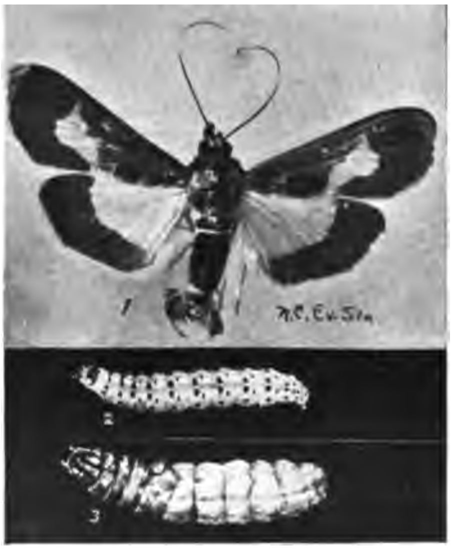

Fig. 1. Pickle Worm. 1, Moth magnified twice; 2, Larva before fourth moult; 3, larva ready to pupate.

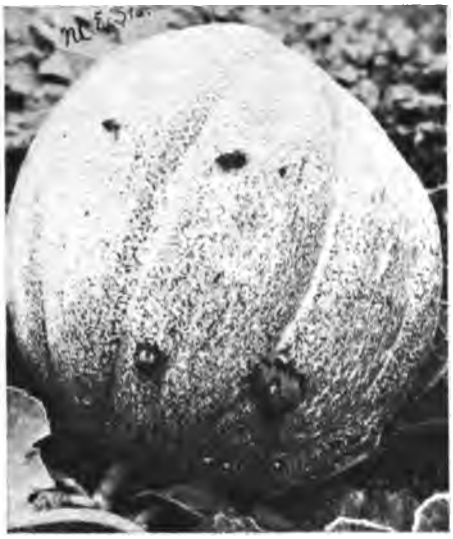

Fig. 2. Pickle Worm Injury to Cantaloup.

Cocoons

The cocoon is a thin, scanty covering of white silken threads, spun by the worm in a fold of some leaf before transforming to the pupal stage. They are generally found in dead or dying leaves near the ground, or lying on the soil under the infested plants.

For this reason the practice of raking up and burning or composting remnants of infested crops, followed by deep plowing, is of value.

Remedial Measures

Early plantings of cantaloupes and cucumbers may escape injury from this pest in the South.

Trap Plants

Pickle worms evince a decided preference for the buds, blooms and fruit of summer squash.

To secure the best results, seed should be planted two or three times at intervals of about three weeks, making the first planting in time to insure having the squash plants blooming freely by the middle or latter part of June. They must then be examined frequently, and, when worms are discovered, infested blooms and fruit should be gathered and destroyed at least once a week.

Destroy infested plants and fruit and as soon as the crop is gathered rake up and destroy all vines, weeds and trash.

R. I. SMITH

N. C. Exp. Sta.

POTATO FLEA BEETLE. See under *Potato Pests.*

Striped Cucumber Beetle

Diabrotica vittata Fab.

General Appearance

The adult beetles are small, measuring about two-fifths of an inch in length and half as much in width. The color is yellow above with black head and three black longitudinal stripes on the wing covers. The under surface as well as parts of the legs and antennae are black. The larvae are very small white grubs with head, anal and thoracic plates brown. They live in the earth. The eggs are oval in shape and bright lemon to orange in color and are laid in the soil.

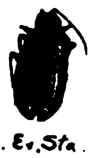

Fig. 1. Striped Cucumber Beetle.

Life History

The adult beetles hibernate over winter under rubbish or in other protected places, and emerge during the early spring months of April and May. As soon as the host plants appear the eggs are deposited in the soil around the bases and hatch in about nine days. The larvae upon hatching feed at the base of the plants upon the roots and stems. The greatest damage is done by the adults boring down into the soil and feeding upon the tender appearing foliage. Throughout the entire summer they continue as foliage destroyers and do much damage. They also act as carriers of the bacterial wilt disease of cucumbers.

Food Plants

Squashes, cucumbers, cantaloupes, pumpkins and watermelons are its favorite food plants and suffer most from its attacks. Peas, blossoms and leaves of the apple and numerous other cultivated and wild plants are devoured.

Control

In many instances control measures are necessary. Cheap coverings are especially desirable for small plantings and may be very practicable for extensive fields. When no coverings are used the plants may be started early in hothouses and set out after they are well established. If the plantings are made directly in the field an excess of seed should be used to allow for the destructiveness of the beetles.

Poison sprays, such as arsenate of lead or Paris green, aid much in controlling it, but successive applications are necessary, because of the rapid growth of the plants. The poisons are sometimes added to Bordeaux mixture and serve as a remedy for fungous diseases as well. In small patches pyrethrum is an excellent remedy.

Repellents such as land plaster or gypsum soaked in turpentine or kerosene or tobacco dust placed around the hills will tend to drive the beetles away. Bordeaux mixture is also considered a good repellent.

E. O. Essig

Common or Greenhouse White Fly

Aleyrodes vaporariorum Westw.

General Appearance

The adult white flies are about three-fiftieths of an inch long, the males being slightly smaller than the females. The bodies are yellow and the wings pure white. The eggs are exceedingly small, oblong in shape, at first light green, growing black with age and attached by a short stipe. The larvae are light in color, transforming to flat pupae about three-hundredths of an inch long; oblong-oval in shape; light green and supporting noticeable wax-like rods or spines, which makes this species readily distinguishable from all others.

Life History

The eggs are laid upon the leaves of the plants, each female depositing over 100. These hatch in about two weeks into larvae which begin feeding very shortly and after three moults, covering nearly a week, they become pupae, which after two more weeks are ready to emerge as adults. These feed during their life of thirty days.

Tomatoes and cucumbers suffer most.

Fumigation as for scale insects is the best method of control, but emulsions and resin sprays are effective.

E. O. Essig

Western Twelve-Spotted Cucumber Beetle

Diabrotica soror Lec.

General Appearance

A small green black spotted beetle about the size of, and often mistaken by farmers for, a ladybird beetle. The ventral surface is entirely black. The larvae are white and subterranean in habits, so are seldom met with.

Life History

The eggs are laid in early spring around the bases of the food plants from one-half to one-fourth of an inch under the ground. They hatch quickly and the white grubs begin feeding upon the roots. The pupal cells are made near the surface and in about two weeks the adult beetles emerge. The broods overlap throughout the summer, there being two distinct generations. The adults hibernate during the winter.

Food Plants

Beets, melons, cucumbers, squashes, beans, corn, cabbages, peas, zinnias, daisies, orange, alfalfa, peanuts, potatoes, spinach, lettuce, mustard, roses and chrysanthemums.

Control

It is seldom necessary to resort to control measures for the larval forms, though they often do much damage. For the adults, however, control measures are often urgent. Poison sprays applied to the tender growth are very effective.

Natural Enemies

Two natural enemies prey upon this beetle; one a tachinid fly, *Celatoria diabroticae* Shim., and the other a spider, *Xysticus gulosus* Keys.

E. O. Essig

Currant

The currant derived its name from the Greek city of Corinth, where it was first cultivated and became commercially important. Many new varieties have been developed, chief of which is the red currant, *Ribes rubrum*, from which have grown several white varieties and many red varieties as well. One peculiarity of the currant is its tendency to variation in color. It is not very unusual to find red, white and striped berries on the same stalk.

There is a black species, *Ribes nigrum*, which is popular in some parts of Europe, but not so in America, because of its peculiar flavor, because it is a light bearer and is not commercially profitable. The principal use to which this fruit is applied is in the making of jellies; although it is used fresh for the table, and in the making of pies.

There is also an American black currant, *Ribes floridum*, or *Americanum*, which resembles the black currant of Europe, but is not much esteemed. There is an American species of flowering currant, *Ribes aureum*, but it is not cultivated for its fruit, since it ripens very unevenly and is not of first-class quality.

On the Pacific coast several varieties classed as *Ribes sanguineum*, are grown for ornament, mostly producing a red flower.

The currant is native to the United States, and many parts of Europe. It thrives best in cool, rather humid climates; upon soil that is rich, well drained, and with a clay subsoil. However, it may be grown in hot climates, if planted on the north side of buildings, or where the plants are shaded by trees of larger growth; provided that the ground is sufficiently fertilized to support the larger trees and currants as well.

The plant is propagated mainly by means of cuttings which may be planted either in the autumn or spring; but if planted in the spring the planting should be early, as they begin to grow earlier than most other shrubs or trees. The cuttings should be made from six to eight inches long, cutting just below the bud for the root, and just above the bud for the top. There is no secret about planting, except that there should be a careful preparation of soil, and the cuttings should be set so that at least two buds shall be below the surface of the soil, and one or two buds above the surface. The planting may be done with a spade, or a furrow may be plowed and the plants dropped against the perpendicular side of the furrow, and the dirt pressed firmly against them. Currants may be propagated by means of roots; but it is generally done by means of cuttings. Seeds are planted, if it is desired to originate new varieties.

There is considerable difference of opinion about the distance of planting; some say the rows should be made four feet apart, and the plants three feet apart in the row. Others say the rows should be eight feet apart and the plants five feet apart in the row. If I were planting and the ground was so that one could use the square method, I would plant them according to that method, five feet apart each way, then cultivate both ways. By this means, I think labor could be saved and better fruit produced. In adopting this method, there would be a waste of land for the first and second years of growth, but if so desired some other crop could be grown between the rows until the currants needed the soil and space.

Cultivation should be shallow, as the roots are fine and grow near the surface of the soil.

Pruning is a simple process, although it is impossible to reach good results if it is neglected. It should be remembered that the fruit is borne on both the old and the new wood, most of it near the base of the one-year-old shoots. Consequently most of the wood more than one year old might be cut out and still a crop be produced, or most of the new wood might be pruned off and a crop result; but the new wood bears the stronger, better fruit, so it is better to sacrifice the old stalks. Card says: "For field culture, four to eight main stems are allowed, and these should be frequently renewed." It is my judgment that wood

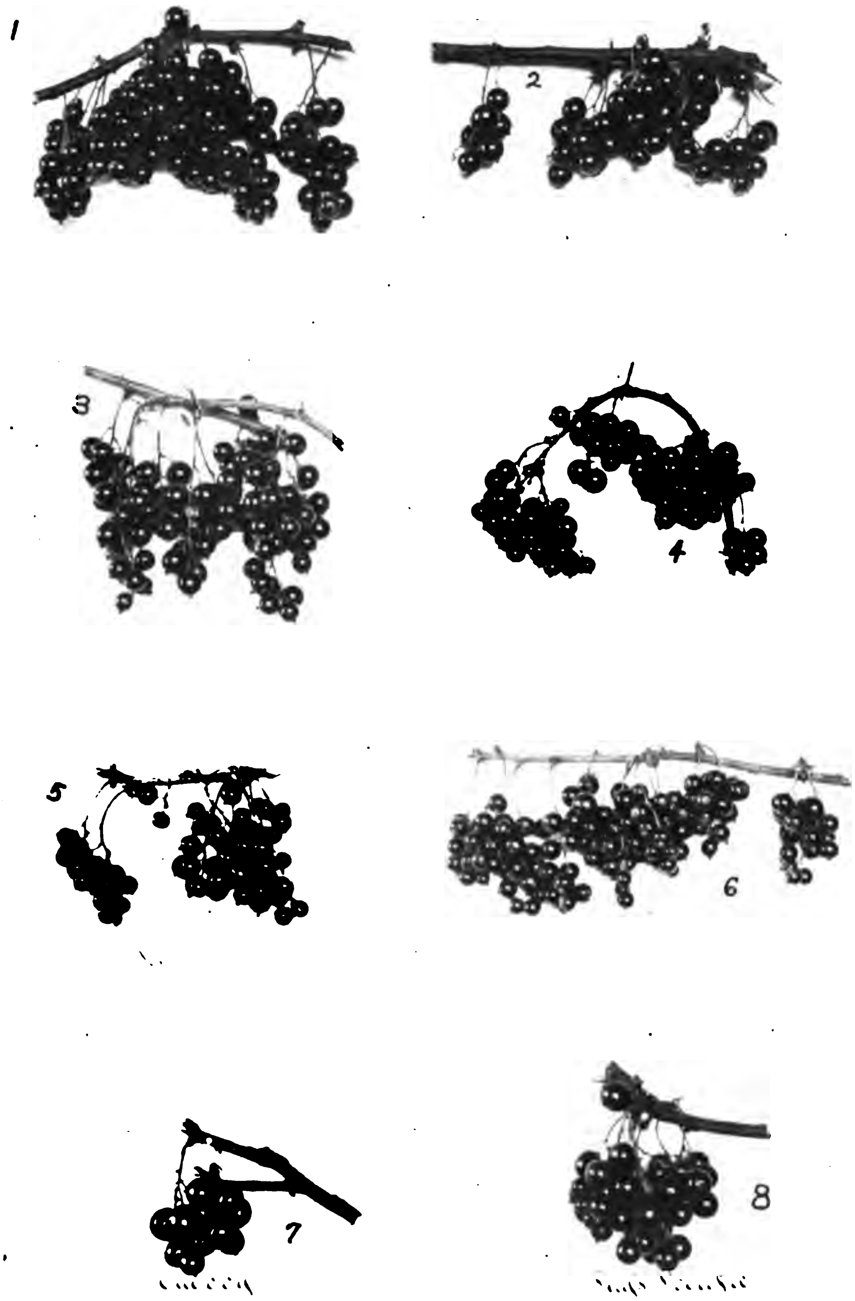

Plate I. Currants. 1. Pomona—Bright red, sweet, very prolific; hangs on a long time; excellent, early. 2. Red Cross—Bright red, large, prolific; mild flavor; excellent, early. 3. Victoria—Bright red, hardy, prolific, a popular variety; blooms late and avoids spring frosts; excellent, late. 4. London Market—Red, firm, acid, prolific, excellent, early. 5. La Versaillaise—Medium sized, dark red, not prolific here. 6. Wilder—Light red, mild, hangs on a long time, excellent, early. 7. Cherry—Dark red, large, not very prolific, good, mid-season. 8. Fay's Prolific—Red, large, prolific, excellent, mid-season.

Photo and Descriptions by J. H. Stahl, Western Washington Experiment Station.

more than three years old should be cut out.

Like most other fruits, currants should not be picked when wet; as they tend to mold or decay if so treated.

GRANVILLE LOWTHER

Currants for the Home Garden or Commercial Plantation

The currant is one of the few fruits that if planted at all in the home garden is permitted to grow at will, usually more or less choked with grass and weeds or rarely or never given any pruning or cultivation. While it will exist under such conditions, it rarely gives satisfactory returns and for this reason is not generally considered a profitable commercial crop in many parts of Washington.

Propagation

The currant, like all other cultivated fruits, does not "come true" from seed, so, for this reason, it is necessary to propagate it by means of cuttings, layers or division.

The wood for cuttings should be of the current year's growth and may be taken any time between the falling of the leaves in the summer and the beginning of growth in the spring. The strongest plants and most satisfactory results are usually secured from cuttings made early in the fall and planted immediately. The cuttings are usually made from seven to eight inches long. The lower end should be cut just below a bud while the upper end may be from one to two inches from a bud, depending upon the length of the wood. If the cuttings are made late in the fall or during the winter it is usually best to pit them in a callousing pit or pack them in damp moss or soil in a cool cellar until early spring. They should then be planted in deep, rich, moist soil in nursery rows three or four feet apart and the cuttings six or eight inches apart in the row. Plant down to the top bud, making the soil very firm around the base of the cuttings in order to prevent drying out during the summer months. After from one to two year's growth the plants will be in excellent shape to set in the permanent plantation.

Soil

Almost any good rich soil of sufficient depth and fertility to produce a good crop of grain will produce good crops of currants. While this class of fruit may be grown in hot, dry soil, the best results are secured on cool, moist soils. A well drained, rich, sandy loam with considerable humus in it, or even clay loam properly treated, will give excellent results if there is plenty of available plant food. When the soil becomes very hot and dry during the summer it is sometimes advisable to mulch with coarse litter in order to hold the moisture and keep the temperature down. It is difficult, however, to grow good, clean fruit under these conditions. As a plant the currant is a heavy surface feeder and so should receive heavy annual dressings of well rotted manure or a substitute for manure in the form of commercial fertilizers.

Planting

One or two-year old plants from cuttings or layers give better results for the permanent plantation. Most planters prefer a one-year-old plant, as it is easier to handle than the two-year-old plants.

Early fall planting gives good results where the plants are mulched before the cold weather comes on, but for general planting early spring gives the best results, especially where the stock is secured in the fall or winter and is set out just as soon as the ground is ready to receive the plants in the spring. Late spring planting is not satisfactory since the rootlets and shoots of the currant begin to form early and are easily damaged in handling.

The same care should be exercised as in planting a fruit tree. All broken or bruised roots should be removed, the top thinned and cut back and the plant set from one to two inches lower than it stood originally in the nursery.

The square planting plan of 6x6 feet is commonly used. However, it does not give sufficient room for the bushy sorts, especially after they begin to bear and the limbs become weighed down with the heavy crops of fruit. A better plan would be to place the rows eight feet apart and the plants six or seven feet in the row. This would allow room for thorough cultivation.

Cultivation

If the plantation has received an application of well rotted manure during the winter this should be worked into the soil as early as the ground is ready to work in the spring. This may be done by shallow plowing or deep, double shovel work. After thoroughly working the manure into the soil the surface should be left smooth and as near level as possible. Regular surface cultivation should continue until picking time. After the crop is harvested, the plantation should again be thoroughly cultivated and then the plants permitted to become dormant and ready for winter. Late summer or fall growths should always be discouraged as there is danger of fall or winter injury resulting from the unripened condition of the shoots.

Pruning

The currant will bear some fruit every year whether it is pruned or not, but, if fine, large fruit is desired pruning is necessary. There are two general types of training currant plants, i. e., the tree form and the bush form. The tree form is developed by cutting away all the shoots but one and the removal of the lower buds and branches from this shoot for from twelve to twenty-four inches from the ground, which results in a little tree. This method does very well for the amateur or the novice, but is not practical from a commercial point of view on account of the unproductiveness of the plant and the danger of a borer destroying a whole plant instead of one cane, as is frequently the case with bush grown plants. The bush form is the more common method used not only in commercial but in home gardens as well and results in the development of a well formed bush of from six to eight two to three-year-old fruiting canes, and from two to four young shoots or one-year-old fruiting canes. The common difficulty with the currant bush is that there is too much wood left annually upon the plant and so it is compelled to produce a great number of small berries instead of greater or equal weight of fine large fruit. While currant wood will produce fruit for an indefinite period of time, yet after it passes its fourth to fifth year it ceases to be valuable on account of the inferior quality of its fruit. Good, healthy wood produces its best fruit during the second and third years of its life and should be replaced by young shoots before it reaches its fifth year.

In ordinary field culture, from five to eight bearing canes on a plant will give better results than a greater number, especially where these canes have been summer pinched in order to develop strong lateral buds. If these shoots have produced strong, lateral shoots they should be cut back to from three to four inches in length. For market purposes it is better to remove too much wood and produce a small quantity of fine fruit than not enough and produce an unsalable crop of small fruit. Pruning may be done in the fall or early in the spring. Ordinarily it is best to do it just before the plants start into growth in spring.

Harvesting and Marketing

Since the currant is largely used for jellies and spice purposes, a rather tart fruit is more desirable than a thoroughly ripened fruit. For this reason as well as the better shipping qualities of slightly green fruit, currants should be picked just before they are ripe rather than after they have become fully ripe. Fruit picked while it is cool ships much better than fruit picked during the heat of the day. Under no consideration must fruit be picked while it is wet with rain or dew, as it soon spoils if handled while wet. The bunch should be removed whole from the plant and kept whole, never shelling or stripping the bunches, as it is sure to lower the grade, if not ruin the fruit entirely.

Up to the present time there is no established method in the West, for marketing currants. The common 24-quart crate is extensively used and is undoubtedly the best and most adaptive Western package. A few growers use a ten or twenty pound shallow box for near markets, but find it unsatisfactory for long shipments. The pony refrigerator can be advantageously used for the fancy grades, but should not be used for anything but the best.

Discussion of Varieties

The size, color, productiveness and attractiveness of the Red Cross currant makes it an especially valuable new sort, while the mild flavor, productiveness and good plants of the Wilder places it at once among our best sorts. The older standard sorts, like the Victoria, Pomona and Cherry, are popular and very valuable for home as well as commercial purposes.

The following notes on varieties were secured from the plants in the experiment station grounds at Pullman, Wash.:

Red Varieties

Cherry

A weak, spreading bush with long canes which frequently break in the wind. The foliage is dark green, abundant and practically free from disease. The berries vary in size from medium to very large, but are usually very large, of a dark red color and are borne in loose, short, poorly-filled clusters. An early to medium productive sort, valuable for home use, but not good for commercial purposes on account of its short-stemmed clusters, which makes picking rather expensive.

Comet

A medium to large, irregular shaped plant with good strong canes and an abundance of dark green, healthy foliage. The berries are rather large, dark red, of a brisk acid flavor and borne in long-stemmed, loose, but well filled clusters. A new, very productive, mid-season sort, not commercially grown.

Fays Prolific

A large, spreading, irregular shaped bush, with good, strong, erect canes and an abundance of large, light green, healthy leaves. The berries are large, of a dark red color, medium acid flavor, and borne on fine, long branches. A very productive, late season sort. Valuable for commercial as well as home use.

La Versaillaise

A large, spreading, irregular shaped bush with good, strong canes and an abundance of large, dark green leaves. The berries are medium sized, of a dark red color, with a brisk acid flavor and borne in long, loose, poorly filled clusters. A good market sort, commonly grown, but not very productive in many parts of the state.

London Market

A large, strong growing, erect bush with slender, erect canes, which stand the wind well, but break very easily when handled during picking. The foliage is dark green, abundant and free from diseases. The berries are medium to large, of a bright red color, mild subacid flavor and very attractive. The bunches are of medium size, short, compact and well filled, making a very showy market sort. A very fine mid-season, productive variety.

Long Bunch Holland

A rank growing, stocky plant, with short, heavy erect canes and an abundance of dark green healthy leaves. The berries are small, of a bright red color, rich acid flavor and are borne in long, loose bunches. A popular mid-season sort, but not so profitable as many larger fruited sorts.

Perfection

A large, strong, upright growing plant, with long, erect, strong canes and an abundance of fine, dark green foliage. The berries are very large, of a bright red color, brisk acid flavor and are borne in short, compact, well filled clusters. A new, very productive, mid-season variety. Valuable for home as well as market purposes.

Pomona

A large, rank growing bush with erect, rather slender canes and an abundance of small dark green leaves. The berries are medium to large, of a dark red color, a mild acid flavor, and are borne in long, well filled clusters. A comparatively new variety for home as well as for market purposes.

Red Cross

A strong, erect growing plant with stiff, short canes and an abundance of dark healthy leaves. The berries are very large sized, of a dark red color; a mild acid flavor and are borne in long, loose well filled bunches. A comparatively new variety that is rapidly becoming popular for market and home use on account of its large size and productive habits.

Red Dutch

A large, irregular shaped bush with slender, long canes and an abundance of fine, dark green foliage. The new canes frequently suffer severe injury from the summer winds. The berries are small, dark red, mild acid and are borne in short, poorly filled clusters. An old, very productive, and, while small fruited, popular sort.

Victoria

A strong growing, upright, productive bush, with heavy upright canes and an abundance of dark green healthy foliage. The berries are very large, bright red, of a mild acid flavor and borne in rather

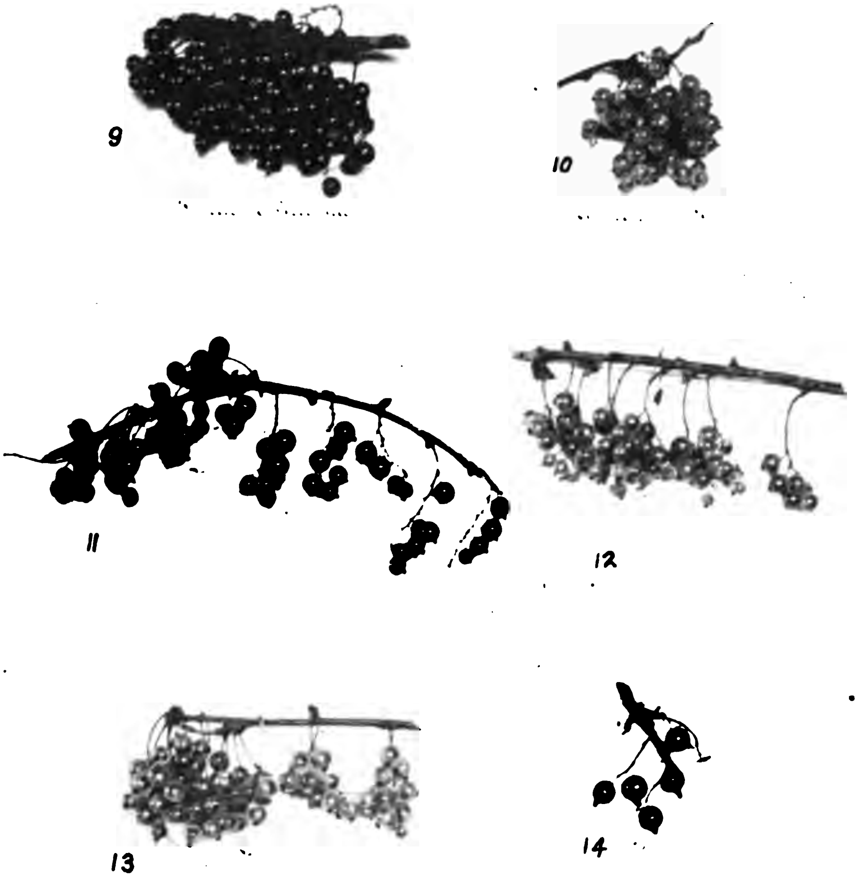

Plate II. Currants. 9. Fertile de Palluau—Large, red, not prolific here. 10. White Grape—White, mild, prolific, excellent, mid-season. 11. Red Dutch—Bright red, acid, small, good. 12. White Transparent—Very similar to White Grape, mid-season. 13. Black Naples—Large, black, not very prolific, good, late.

Photo and Descriptions by J. H. Stahl, Western Washington Experiment Station.

small, poorly filled loose bunches. One of our best late sorts.

Wilder

An irregular shaped, spreading, very productive bush with strong, spreading canes and an abundance of fine dark green foliage. The berries are of medium size, dark red color, very mild subacid flavor and are borne in loose, short stemmed bunches. Its mild flavor and fine quality with other admirable traits make this an excellent sort where a table fruit is desirable.

White Varieties

White Grape

A medium sized, flat spreading, very productive bush, with long, slender canes and an abundance of healthy, dark green foliage. The berries vary greatly in size, but average well, are of a light greenish white color and excellent quality. The bunches are long, loose and poorly filled. A very valuable sort for home table use, but not popular as a market sort. The yellow and white fruited forms of practically all kinds of small fruit are not so popular in the market as the bright colored sorts.

European Black Varieties

Black Champion

A large, rank growing, spreading bush with slender, recumbent canes and an abundance of dark green foliage. The berries are medium sized, black, of good quality, and are borne in short, poorly filled bunches. While a very rank grower, this variety is a very shy bearer.

Black Victoria

A very large, strong growing plant, with strong, erect canes and plenty of dark green foliage. The berries are of medium size, pure black color and pleasant flavor. The bunches are medium sized but poorly filled. This is the best and most productive black sort tested. None of the black varieties are of commercial importance in the West but are occasionally grown for home use.

American Black Variety

Crandall

A large, rank growing, spreading plant with long, strong, erect canes and a rather small amount of light green foliage, which is frequently diseased. The berries are variable in size, of a blue black color and rather sweet flavored. The bunches are small, poorly filled and the plants are not very productive.

None of the Missouri Yellow Flowering currants are profitable for fruit production; nor should they be grown near the red or white sorts as they are nearly always the harboring places for the currant fruit worm, which is so hard to combat and does so much damage in many parts of the state.

W. S. Thornber,

Washington Experiment Station Popular Bulletin 26.

Currants for Alaska. See *Alaska*.

Varieties To Be Planted

The following varieties are recommended by the American Pomological Society for planting in the various districts: (See Map, p. 192.)

District No. 1

Recommended as successful — Champion, Lee's Prolific, Naples, Saunders, Albert, Red Cross, Red Dutch, Red Grape, Versaillaise, Victoria, White Dutch.

Very successful—Cherry, Fay, White Grape, Wilder.

Recommended for trial—Moore's Ruby.

District No. 2

Successful—Champion, Lee's English, Naples, Saunders, Albert, Holland, London, North Star, Pomona, Red Dutch, Versaillaise, Victoria, White Dutch, White Gondouin.

Very successful—Cherry, Fay, Red Cross, Wilder.

Recommended for trial — Wales, Moore's Ruby, Perfection, Raby Castle, St. Giles.

District No. 3

Successful—Lee, Moore's Ruby, Red Dutch, Versaillaise, Victoria, White Dutch, White Gondouin, White Grape.

Very successful—Cherry, Fay, Wilder.

Recommended for trial—Naples.

District No. 4

Recommended as successful—Black Champion, Lee, Wales, Victoria, White Dutch, Wilder.

Very successful—Cherry, Fay, Red Dutch, White Grape.

Recommended for trial—Crandall, Albert.

District No. 5

Recommended as successful—Crandall.

Recommended for trial—St. Giles.

District No. 6 and District No. 7

Includes Florida, and the Southern states bordering on the Gulf where it is too hot for currants.

District No. 8

Recommended as successful—Champion, English, Holland, Versaillaise, White Dutch, Wilder.

Very successful—Cherry, Fay, Perfection, Red Dutch, Victor, White Grape.

Recommended for trial — Crandall, Wales.

District No. 9

Recommended as successful — Champion, English, Lee, Naples, Wales, Albert, Cherry, Fay, Perfection, Red Cross, Red Grape, St. Giles, Victoria, Wilder.

Very successful — Holland, London, North Star, Pomona, Red Dutch, White Grape.

Recommended for trial—Saunders.

District No. 10

Recommended as successful—Cherry, Defiance, North Star, Red Cross, St. Giles, White Grape.

Very successful — Red Dutch, Red Grape.

District No. 11

This district includes a part of Texas and New Mexico, and is not adapted to currants.

District No. 12

Recommended as successful—Albert, Holland, Victoria, White Grape.

Very successful—Cherry, Fay, Red Dutch, Versaillaise, White Dutch.

Recommended for trial—English, Lee, Red Cross, Red Grape, White Gondouin, Wilder.

District No. 13

Recommended as successful—Champion, Lee, Naples, Saunders, Wales.

District No. 14

Recommended as successful—Champion, North Star, Red Cross, Red Dutch, Red Grape.

Very successful—Cherry, Fay, White Grape.

Recommended for trial—Perfection.

District No. 15

Recommended as successful—Cherry, Victoria.

Very successful—Fay, White Dutch, White Grapes.

District No. 16

Recommended as successful — Fay, White Dutch.

District No. 17 and District No. 18

Include part of California and Arizona, where it is too hot for currants.

CURRANT DISEASES

Anthracnose

Pseudopeziza ribis

H. S. Jackson

Currant anthracnose seems to be the most common fungous disease of this fruit which occurs on the Pacific coast. It seems to be widely distributed in the state and is generally known throughout the United States. It is also common in Europe. This disease is known to attack the gooseberry, but usually not in a serious form. It is more severe upon the red and white currants than upon the black.

Symptoms

The disease is primarily a leaf disease, though it may grow upon practically all parts of the plant above ground including the fruit. On the leaf the disease causes small brown spots which are more or less thickly scattered. When abundant the affected leaves turn yellow and fall. This disease is probably the cause of much of the premature defoliation of currants. The general effect of the fungus is to interfere with the proper development of the fruit and generally to reduce the vitality of the plants, thus interfering with the proper ripening of the fruit and the formation of the fruit buds for the next year. Spots of the disease may also occur upon the petioles and young canes and upon the fruit stalks and young fruits. Conspicuous black spots which are slightly sunken are formed on the leaf stalks and petioles and also on the fruit stems. Here the spots are black and from one-fourth to one-half inch long. On the fruit black spots resembling fly-specks are formed.

On the young canes the disease produces only a slight discoloration; it occurs only upon young canes of the current year's growth, and is very difficult to detect.

Where plants are in partial shade they are not as seriously attacked. Older plantations are found to be more seriously affected than more recent plantings.

Cause

This disease is caused by a fungus known technically as *Pseudopeziza ribis*. The fungus exists in two spore stages. In the spots on the leaves, petioles and canes, the summer spores are produced in peculiar fruiting structures known as acervuli; these are doubtless disseminated by wind and spattering rain, and when coming to rest upon any part of the plant grow into the tissues and cause new spots.

It has been proved that the fungus matures on the stems, and it is possible that it winters over on the canes in this condition.

It is certain that the fungus is catried over the winter by the foliage, which lies on the ground.

Treatment

The first infection results from the dissemination of spores from the dead leaves of the previous season, and any method of destroying these leaves might tend to reduce the seriousness of the attack. It would be advisable, therefore, to plow early, before the leaves come out in the spring, in order to bury the dead leaves. Where practicable, raking and burning the leaves would have the same result and would probably be more effective. A dormant spraying toward spring, to prevent any further development of the summer spores on the canes, would be advisable. Use the Bordeaux mixture 5-5-50. Spray again when the leaves unfold and repeat at intervals of ten days until the fruit is two-thirds grown, avoiding the blossoming period. If summer rains are abundant it may be found profitable to spray once or twice after the fruit is gathered.

BLACK KNOT. See under *Cherry Diseases*.

Cane Blight

Nectria cinnabarina (Tode) Fr.

This is a very serious disease whenever stools are attacked by it. The fungus survives by its threads in the tissues of the stool and upon the death of the canes develops as a bright pink mass of the fungus upon dead parts. While spraying may, and surely must, keep down the risk of infection, whenever stools show attacks by dying of a part of the canes and the development of this fungus these infected stools are doomed and should be removed and burned. A. D. SELBY

Reference

Duggar, Fungus Diseases of Plants.

Currant Blight, Currant Cane Blight, Currant Cane Necrosis

Botryosphaeria ribis

An Old, Obscure Disease

More than twenty years ago, a disease was discovered which has become today a very destructive trouble in the currant plantations of the Hudson valley, New York. The cause of this disease remained long unknown; but careful study by botanists of the Geneva and Cornell stations proved it to be due to a fungus which has three distinct spore forms. Of these, the basal form is *Botryosphaeria ribis*, so that this stands as the scientific name of the fungus which causes currant blight, currant cane blight, or currant cane necrosis. Usually, the discovery of the cause of a disease soon leads to a remedy, but in this case no preventive or remedial treatment can yet be recommended.

Symptoms of the Disease

On certain canes, or portions of the canes, the leaves wilt, turn brown and die. An affected cane will show a section of dead wood from one to four inches long where the bark has been killed and wood and pith invaded by the mycelium of the fungus. This hinders the ascent of sap and thereby causes all the upper part of the plant to wither and die. The general appearance is very similar to that caused by borers in the canes, but when this insect is responsible, a distinct burrow will be found and the larva, itself, may be present. In fungus-blighted canes, neither burrow nor larva can be found, but on careful examination, especially with a microscope, fine, whitish, cobwebby threads may be discovered in the discolored pith at the point of attack.

Dropsy

This disease causes very considerable enlargement upon the young stems of the currants, not unlike in appearance the enlargements due to crown gall in the peach, except that usually more of the stem is involved than in the other case. The trouble appears to be due to physiological causes and the pruning knife may aid cultural efforts.

European Currant Rust

Cronartium ribicola Fisch. de Waldh

An outbreak of this rust has been reported from New York, although before 1906 supposed to have been confined to Europe and Asia. It appears also upon the white pine. No practical means of control seems at hand.

References

Ohio Bul. 214.

Duggar, Fungus Diseases of Plants.

Knot

Due to a fungus, requires further investigation.

Leaf Spot

Septoria ribis, Desm.; *Cercospora angulata* Wint.

Leaf spot of currants is referable to two species of fungi. These fungi produce early spotting and premature dropping of the currant foliage; in some instances the leaves drop even before the fruit has ripened. Bordeaux mixture applied as per calendar is effective against this disease, though late applications may render it necessary to wash the fruit. For this reason, if for no other, the first application should be made very early and followed by about two more at fortnightly intervals.

A. D. S.

Powdery Mildew. See under *Gooseberry Diseases.*

Wilt. See *Currant Blight* this section.

CURRANT PESTS

American Currant Borer

Psenocerus supernotatus Say

When red and white currants are leafing out in spring, some bushes are noticeably slower in expanding their foliage than other individuals of the same variety. This is frequently due to the presence of stem-boring larvæ, either those of the above beetle, which are white, cylindrical, and without feet, about a quarter of an inch in length, or those of the imported currant borer, which somewhat resemble the above but have a brown head and short legs beneath the body. The parent of the American currant borer is a small, narrow, brownish-black beetle, about ¼-inch long, with long slender feelers and two conspicuous white spots on the back towards the end of the body, and two smaller dots about the middle. These beetles may sometimes be found in the month of June crawling about upon the bushes. The eggs are laid in summer, and the young grubs burrow inside the canes and do not change to pupæ until the following May. The attack of this insect, although occasionally serious to fruit growers, is only an exceptional one, for the species propagates much more freely in the stems of the Virginian creeper.

Remedy

When currant bushes are being pruned, all the wood which is cut out should be burnt, and if the presence of this insect or of the currant borer is detected by the black burrows in the centers of the stems, such stems should be pruned down until the larva is found, so that it may be destroyed.

Cottony Scale. See *Apple Pests.*

Currant Aphis

Myzus ribis L.

When the leaves of currant bushes are nearly full grown, many of them bear blister-like elevations of a reddish color, beneath which will be found yellowish plant-lice, some winged and some wingless. The blisters are due to the attacks of these insects, and when, as is sometimes the case, they are very abundant, considerable injury is done to the bushes.

See *Aphids*.

Remedy

Spraying forcibly with whale-oil soap solution or kerosene emulsion will destroy large numbers of these plant-lice at each application; but the liquid must be copiously applied and driven well up beneath the foliage by means of an angled nozzle. Two or three applications at short intervals may be necessary.

Currant Leaf Hopper

Empoasca mali, Le Baron

A frequent cause of considerable injury to the leaves of currants and gooseberries, is a small pale green leaf hopper which during May and June is found in large numbers beneath the leaves, from which it sucks the sap. This is the same insect that is often so abundant upon apple trees. The mature insect is a slender leaf hopper less than ⅛ of an inch in length, and passes the winter beneath rubbish, leaves, etc. It flies to the bushes in spring, as soon as they leaf out. The young wingless leaf hoppers of the first brood may be found about the beginning of June, and should be destroyed before they develop their wings and propagate.

Remedy

Spraying the bushes with kerosene emulsion or whale-oil soap solution before the insects become winged, is the best remedy. Care must be taken to drive the liquid well up under the leaves.

See also *Apple Pests*.

James Fletcher,
Ottawa, Can.

Currant Maggot or Gooseberry Fruit Fly

Epochra canadensis Loew

A. L. Lovett

This insect is possibly as serious a pest of the currant and gooseberry fruits as we have in the Northwest. The attack is on the fruit itself and causes it to become prematurely ripened and altogether worthless. The first indication of injury due to this insect is a small spot on the one side of the fruit where growth has apparently ceased. Later the fruit shows a cloudy appearance, becomes prematurely ripe and upon examination reveals a dark spot in the interior, which proves, when the fruit is opened, to be a small footless grub. The fruit drops to the ground, and as a result, the crop is shortened greatly or is entirely ruined.

The adult of this maggot is a very pretty two-winged fly about the size of a house fly. It is of a pale yellow or orange color. The wings are marked with dusky bands. The grub or maggot is footless, white in color and with the body composed of 13 segments. The head is armed with a pair of black, parallel, retractile hooks, the rasping organs of the maggot.

Life History

The adult flies emerge during May and may be observed about the bushes during late May and June. Soon after emergence the female commences depositing eggs. One female may lay as many as 200 eggs; usually she will deposit but a single egg in a fruit. The egg-laying process is interesting; the fly alights on the fruit and hurries about in a nervous manner, keeping the wings in constant fanning motion. When at last suited with the location she pierces the fruit with her ovipositor and pushes the egg under the edge of the skin. The egg hatches into a small white grub, which at once commences to feed and travel. Its route may be readily traced just under the skin by the discolored path of injured cells and excrement left behind. After traversing a greater or less distance around the fruit, the maggot turns to the interior and enters one of the seeds. After growing too large to remain in a seed, it binds several seeds together and continues to feed on their contents. Occasionally the larvæ leave the fruit before it drops to the ground. More often they remain in the fruit until after it has fallen, where they complete their growth, and when ready to transform to a pupa crawl out of the fruit and into the soil. They enter the soil to a depth of about one and one-half inches, where they form an earthen cell and transform to a pupa. They remain in the soil as a pupa until the following May when they emerge as adult flies.

Control Measures

This insect is not an easy one to control. The fact that the egg is deposited under the skin of the fruit and that the larva spends its entire existence in the interior, makes poison sprays for the larva of no avail.

Sweeping

An insect net swept over the vines in the early forenoon during June should collect many of the flies. They could then be dipped in hot water or suds.

Poultry

Young poultry allowed to run in the patch a few hours each day will pick up the fallen fruit containing the maggots and materially lessen next season's crop of flies.

Spading

Advantage may be taken of the fact that the pest spends nearly 11 months in the soil. Spade up the soil thoroughly to a depth of four or five inches close up about the bushes. This will break up the pupal cells and expose the insect to unfavorable weather conditions and the attack of its enemies.

Mulching

Mulching heavily with straw in the spring might prevent the flies from emerging as they are very weak when newly emerged.

Currant Soft Scale

Lecanium ribis Fitch

There are occasionally noticed upon the stems of currants and gooseberries clusters of large swollen dark-brown polished scales, about 1-10 of an inch in diameter, beneath which, when mature in July, large numbers of white eggs may be found. These hatch during that month, and the small, mite-like young crawl all over the plant and suck the sap from the leaves and young growth. By autumn they have grown but little and are covered with a flat brown scale about 1-32 of an inch in length. As winter approaches, they crawl on to the twigs and pass the winter there. During the spring of the next year they grow rapidly and, as they are sometimes in such numbers as almost to cover the twigs, they do a considerable amount of harm by sucking the sap at the time when the bushes require all their vigor to ripen fruit.

Remedy

Spraying the bushes in winter time either with the lime-sulphur wash or with kerosene emulsion, is the best treatment for this scale.

Currant Span Worm

Cymatophora ribearia Fitch

This voracious caterpillar, which frequently does much harm to currants and gooseberry bushes, but particularly to the black currant, is more difficult to control than the common currant worm, the larva of the imported currant sawfly. The caterpillars are about an inch in length, of a whitish color, with yellow stripes down each side, and one down the middle of the back; the whole body is dotted with black spots of different sizes. There is only one brood of this insect in the year, the moths appearing about the end of June and in the beginning of July. The eggs are laid on the twigs during the latter month, and remain there unhatched until the following spring. The caterpillars may be found during June.

Remedy

It is necessary to use a much stronger poison for the currant span worm than for the ordinary currant worm. Paris green, arsenate of lead, or some other arsenical poison, are preferable to the white hellebore usually recommended. When occurring only in small numbers, handpicking is practicable, owing to the habit of the caterpillar of letting itself down by a strong silken thread when the bushes are disturbed.

In addition to the above, which is the commonest of the span worms found on gooseberries and currants, there are occasionally found two much larger caterpillars of the same shape and looping movement of the body when walking. These are those of the currant angerona (*Xanthotype crocataria*, Fab.) which has a caterpillar an inch and a half long or more when full grown, of a yellowish-green color, with a whitish line down the back and a broad white band on each side bordered with pale purple, below the spiracles, and the pepper and salt currant moth (*Lycia cognataria*, Gn.), which has a large caterpillar two inches long, varying in color from green to dark brown, and when at rest standing out rigidly, like many of the other span worms, so as to resemble a twig or the stem of a leaf. Neither of these latter caterpillars is a regular pest of the small fruit grower; but they occasionally appear in such numbers as to require attention. They are easily controlled by the same remedies as given above.

JAMES FLETCHER,
Ottawa, Can.

Currant Stem Girdler

Janus integer

After the leaves have fallen so that the stems of currant are well exposed many among them are sometimes observed to have been pruned off across the top, and by splitting the cane, a tunnel is found running down the pith chamber for from four to six inches. The excrement or frass of the borers is scattered along the tunnel and after early September the lower part of the tunnel will be found to have been cleaned out and is occupied by the grub, enveloped in a thin silken cocoon. A passageway from the center to the bark is eaten out and by means of this opening the adult sawfly, into which the grub transforms, makes its way to the outside the following May. The sawfly is a close relative to the insect which lays eggs to produce the well known currant worm. It has four wings, a shining black body, and light brownish legs. The abdomen of the male is brownish yellow, while in the female the first half of the abdomen is of a reddish-orange color and the rest is black. This insect is known as the currant stem girdler.

Remedy

By cutting off and burning about eight inches of the tips from the girdled canes, any time during the occupancy of the tunnel by the larva, the insect will be controlled.

H. A. GOSSARD,
Ohio Bulletin 233.

Currant Worm or Imported Currant Sawfly

Pteronus ribesii Scop.

By far the best known of all the insects which injure currants and gooseberries, is the "Currant Worm." The black spotted dark green false-caterpillars of this insect may unfortunately be found in almost every plantation of currants or gooseberries, every year in almost all parts of Canada. The white eggs are laid in rows along the ribs of the leaf on the lower side, towards the end of May. From these the young larvæ hatch and soon make their presence known by the small holes they eat through the leaves. Unless promptly destroyed, they will soon strip the bushes of their leaves, thus weakening them considerably so as to prevent them ripening fruit the first year, and also reducing the quality of the crop of the following season. There are at least two broods in a season in Canada. The first appears just as the leaves are attaining full growth, and the second just as the fruit is ripening. The perfect insect is a four-winged fly which may be seen flying about the bushes early in spring. The male is blackish, with yellow legs and of about the same size as a house fly, but with a more slender body. The female is larger than the male and has the body as well as the legs yellow.

Remedy

For the first brood a weak mixture of Paris green, 1 ounce to 10 gallons of water, may be sprayed over the bushes, or a dry mixture 1 ounce of Paris green to 6 pounds of flour may be dusted over the foliage after a shower or when the leaves are damp with dew. For the second brood Paris green must not be used, but white hellebore; this is dusted on as a dry powder, or a decoction of this powder. 1 ounce to 2 gallons of water, may be sprayed over the bushes. It is, of course, far better to treat the first brood thoroughly, so as to reduce the number of females which would lay eggs for the second brood.

Four-Lined Leaf Bug

Poecilocapsus lineatus Fab.

An occasional injury of no very great importance, as a rule, to the leaves of currants and gooseberries, is by the four-lined leaf bug. The eggs of this insect are inserted into the twigs of bushes, particularly currants. They are usually placed near the tips and protrude slightly through the bark. As they are white, they can be easily seen and, when once known, can be recognized again without difficulty. Much good may be done in controlling this insect by cutting off all egg-bearing twigs when pruning. The mature insect is a flat, bright green or yellow bug, with four black lines down the back and with the tips of the wings and two large round spots on the thorax also black. The nymphs or immature bugs occur with the adults near the tips of shoots and are exceedingly active. These insects puncture the young leaves of currant and gooseberry bushes as well as of many other kinds of plants, causing brown spots which are sometimes so numerous and close together as to make the leaves wither.

Remedy

When, as is generally the case, only a few bushes are attacked, shaking off the nymphs and perfect insects into open pans containing water with a little coal oil on the top, is often sufficient. If the attack is more extensive, spraying the bushes with kerosene emulsion or whale-oil soap solution will destroy all the insects reached by the spray. The winter is passed in the egg state, therefore, all egg-bearing twigs should be cut off and burnt.

James Fletcher,
Ottawa, Can.

Gooseberry Gall Midge. See under *Gooseberry Pests.*

Imported Currant Borer

Sesia tipuliformis Clerck (Family Sesiidae)
Aegeria tipuliformis Clerck.

General Appearance

The adult females are clear-winged moths with delicate, slender bodies about three-eighths of an inch long and a wing expanse of from five-eighths to three-fourths of an inch. The general color is jet black with deep blue iridescence. There is a yellow band around the base of the head; three distinct and two indistinct yellow bands around the abdomen and two oblique longitudinal yellow stripes on the thorax. Because of sunshine these lines and bands are misleading in the photograph (Fig. 1) excepting the last two abdominal rings in the left-hand specimen. The areas on the thorax just below the wings are also yellow. The fore wings are opaque along the borders, with a small band enclosing a clear area near the opaque tips which are bronze. The hind wings are clear, excepting a brown border. The legs are banded yel-

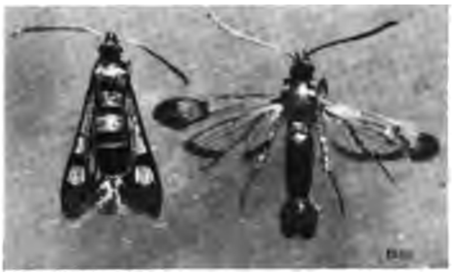

Fig. 1. Adult Females of the Imported Currant Borer, *Sesia tipuliformis* (Clerck). The light-bands on the bodies are somewhat confusing, due to extremely bright light when the photograph was taken.

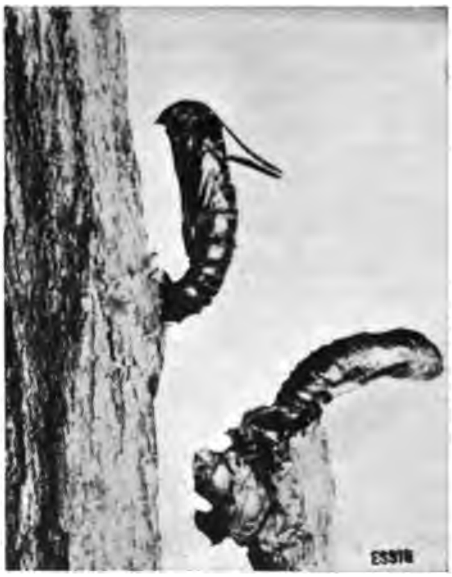

Fig. 2. The Pupae Cases of the Imported Currant Borer, from which the adult moths have emerged.

low and black with the inner sides of tibiae and tarsi yellow and the outer sides black. The larvae are slightly more than half an inch in length and yellowish white, with dark heads. The chrysalids are amber brown.

Life History

The eggs are deposited in the early summer and the young upon hatching bore into the canes of the currants and work upon the inner pith during the summer and winter, eventually destroying the bushes. Late in the spring the pupæ are found within the old burrows near an opening through which the adult emerges, drawing nearly all of the pupal case after it. The winter is passed in the larval stage.

Distribution

Canada and the United States.

Food Plants

The young caterpillars work on the pith within the stalks or canes of the currant and gooseberry, doing much damage to the fruit-bearing wood. In not a few cases entire patches have been rendered worthless before the unsuspecting grower was aware of the real cause of the dying bushes.

Control

Control is rather difficult and consists in cutting out and burning the sickly-looking canes as often as they appear.

E. O. Essig

IMPORTED CURRANT SAWFLY. See *Currant Worm*, this section.

Oblique-Banded Leaf Roller

Archips rosaceana Harr.

Late in May and during June the leaves at the tips of young shoots of currants of all kinds may be seen gathered together by active pale green caterpillars about three-fourths of an inch long, with black heads. Upon tearing the leaves apart these wriggle quickly out of their shelters and fall to the ground. When full grown, which is during June, the caterpillars change to brown chrysalids inside their tents, and from these a little later the moths appear. These are flat and broad in shape, resembling a bell in outline when at rest. The front wings are light brown, crossed by broad oblique bands of a darker tint. The hind wings are of a pale ochre yellow. The moth expands about an inch across the wings. The caterpillars are very general feeders and may be found on a great number of trees and shrubs.

Remedy

Spraying bushes with Paris green and water to destroy the first brood of the currant worm, will control this caterpillar also, as it occurs about the same time. The clusters of leaves containing the larvæ are easily noticed and should be pulled apart and the caterpillars killed whenever detected.

Oyster Shell Scale

Mytilaspis ulmi L.

Several kinds of scale insects attack currants and gooseberries. These plants seem to be particularly susceptible to the attacks of the well known oyster shell scale of the apple, and the San Jose scale. In neglected plantations these injurious insects increase rapidly, and a great deal of injury results to the trees.

Remedy

The remedies for scale insects are direct treatment for the destruction of the infesting insect, and preventive measures such as the invigoration of the tree by special culture and pruning, to enable it to throw off or outgrow injury. Infested plantations should be cultivated and fertilized early in the season, and all unnecessary wood should be pruned out. As direct remedies, spraying the bushes at the time the young scale insects first appear in June with kerosene emulsion or whale-oil soap, or spraying in autumn before the hard weather of winter sets in with a simple whitewash made with one pound of lime in each gallon of water, gives the best results. Two coats of the whitewash should be applied, the second one immediately after the first is dry. In putting on two thin coats of the wash instead of one thick one, far better results have been secured. For the San Jose scale the lime and sulphur wash is necessary, and must be repeated every year.

"Red Spider"

Tetranychus species

In dry years great injury is occasionally done in plantations of currants and gooseberries, as well as on raspberries, apples and many other kinds of fruits, by various species of spinning mites which are usually spoken of in a general way, by horticulturists, under the name of "Red Spiders." These are all very minute reddish, or greenish white, mites that are found on the lower surfaces of the leaves, which they cover with a fine network of web in which they live and which renders it difficult to get at them with ordinary liquid applications. These minute creatures propagate very rapidly, and their injury to trees by sucking out the juice of the leaves is very soon apparent by the bleached appearance of the foliage, which soon dries up and falls away.

Remedy

It is probable that most of the kinds of "Red Spiders" pass the winter as eggs on the bushes. Plantations which have been infested one year, should be thoroughly sprayed early in spring with the lime and sulphur wash. Sulphur has a specially fatal effect upon all kinds of mites. If bushes are found to be infested in spring or summer time, they should be sprayed forcibly with kerosene emulsion, which might be followed in persistent attacks, which often occur, by dusting the bushes while wet with powdered sulphur by means of one of the so-called insect guns or horticultural bellows.

James Fletcher,
Ottawa, Can.

Scurfy Bark Louse. See under *Apple Pests*.

Yellow Currant Fly. See *Currant Maggot*, this section.

Cytology

Cytology is the science which deals with the structure, development, and functions of the cell; of the multiplication of cells into organs and tissues. The cell has been defined as "A mass of protoplasm with a nucleus in it."

History of Cell Theory

Cells were first discovered in various vegetable tissue, by Robert Hooke, in 1665, but it was not until the beginning of the nineteenth century that any insight into the real nature of the cell and its functions was obtained. In 1846, Hugo von Mohl was the first to recognize that the essential vital constituent of the plant cell is a slimy protoplasmic mass, inside of the cell and not the cell itself. This mass was called the nucleus, and was distinguished from the cell wall which is now supposed to be a protection to the vital part, rather than the vital part itself.

The cell theory, in so far as it relates to plants, was established by Schleiden in 1838. He showed that all the organs of the plants are built up of cells, that the plant embryo originates from a single cell and that the physiological activities of the plant are dependent upon the individual activities of these vital units. This conception of the plant as an aggregate or colony of independent vital units governing the nutrition, growth and reproduction of the whole, cannot, however, be maintained. It is true that in the unicellular plants all the vital activities are performed by a single cell, but in the multicellular plants there is a more or less highly developed differentiation of physiological activity giving rise to different tissues, or groups of cells, each with a special function. The cell, in such a division of labor, cannot therefore be regarded as an independent unit. It is an integral part of an independent organism and, as such, the exercise of its functions must be governed by the organism as a whole.

Size of Cells

Prof. Charles Joseph Chamberlain, University of Chicago, says:

"Most cells are too small to be seen with the naked eye, cells which are visible without the microscope being exceptional rather than the rule. The egg of a bird consists of a single cell, as do the eggs of animals and plants. The largest plant cells are the internodal cells of the stonewort, *Chara*, which reach a length of two inches. The largest egg cell for any plant is that of the *Zamia*, a plant related to the sago palm; this cell reaches a length of about one-eighth of an inch.

"The most usual shape of the free cells is the spherical, and cells forming a part of a tissue are more or less rectangular in form.

"When first formed, the cells of the individual animal or plant are very much alike, but as one examines the cell further from the regions where actual cell multiplication is taking place, it is seen that the originally similar cells are becoming very unlike. In the higher plants, the outer cells become differentiated into protective tissue, the innermost into conductive tissue, others into assimilative tissue, and still others become reproductive cells. In higher animals, similar differentiations take place, cells which finally become so different as those which form nerves, muscles, glands and even teeth, having been practically alike in the beginning. Among the unicellular organisms, there is often remarkable differentiation and division of labor, the single cell performing the functions of locomotion, securing food, digestion, assimilation, etc. Such differentiation and the causes which lead to it are among the most important cytological problems.

"It is a remarkable fact, that while undergoing nucelar division, the cells of plants and animals strikingly resemble each other, even in the behavior of the most remote constituents of nucleus and protoplasm.

"This must mean that animals have been derived from plants, or that structures of amazing similarity have arisen independently in animals and plants.

Fertilization

"Fertilization is one of the most important problems of cytology. While new individuals without fertilization, even in the more highly organized animals, may occur occasionally (by parthogenesis, chemical stimulus, vegetative multiplication, etc.) such cases are so rare, that fertilization is assumed to occur, unless its absence is clearly established. To the cytologist, fertilization consists in the union of definitely organized male and female elements. The cytological details of fertilization of plants and animals are essentially alike. Fertilization both in plants and in animals is preceded by a reduction in the number of chromosomes, so that the number of chromosomes found in the male nucleus or in the female nucleus is just one half the number found in the body cells of a given plant or animal. Consequently, when the two sexual nuclei fuse during fertilization, the number of chromosomes which characterizes the body cells is restored. The complicated details of the process by which this reduction in the number of chromosomes is effected is essentially alike in plants and animals. Those cytologists who have investigated most thoroughly the phenomena of fertilization have come to the conclusion that heredity is referable to a definite cytological basis.

A Cytological View of Heredity

"Almost without exception, cytologists have believed that chromatin is the physical basis of heredity. The reasons for this belief are briefly as follows: The male and female parents are about equally potent in transmitting characters to offspring; an equal amount of chromatin and an equal number of chromoses are contributed by each parent; nothing but chromatin is contributed equally by each parent. There is usually a great difference in size between the male and the female germ cells. The sperm cell (*spermatozoan*) of the ostrich, is almost invisible to the naked eye, while the egg is as large as a cocoanut, and such differences in size are usual both in plants and animals. The egg contains a large amount of protoplasm and various food stuffs and in many cases even that little is left outside at the time of fertilization, only the nucleus entering the egg. Hence, protoplasm and foodstuffs do not transmit hereditary characters. While the male nucleus is usually the smaller at the time of its entrance into the egg, it increases in size so that at the time of fusion the sex nuclei are alike in size.

"The organization of embryos and mature organizations from eggs is a cytological problem which has not yet been solved. The visible stages in development have been observed and described *ad infinitum.* Both experimental cytology dealing largely with living material, and anatomical studies of thin sections, stained so as to show the most minute details of structure, are contributing to the solution of the problem, but the fundamental underlying phenomena are still unknown and seem as difficult as the problem of life. The eggs of the sunflower and the willow, like the eggs of flowering plants, are too small to be examined with the naked eye, but even when examined by the aid of modern technique and the most powerful microscopes, they present no essential difference in external appearance, nor in external structure, and yet one will always develop into a willow, and the other into a sunflower. Within the fertilized egg are all the potentialities of the adult, even to the color of the flower, or the markings of the wings of the butterfly.

"This view of Professor Chamberlain, is in substance supported by H. M. Bernard, an eminent French scientist, who in 'Some Neglected Factors in Evolution,' published in 1911, outlines his work as follows:

" 'The cell, long considered to be the unit of organic structure, is here treated as a form-feature of a fundamental network universally present in protoplasmic tissues. The most primitive organisms are, essentially, living networks from which all the tissues and organs of the higher animals and man have become differentiated, in response to an ever-widening range of environmental stimuli.

" 'The periodic rise in the level of organic life through the appearance of new types of animals, which the Darwinian theory of variation does not explain, is attributed to a series of units of structure, starting with one simpler than the cell. Each of these units in turn, by colony-formation, has succeeded in producing an organism of a more complicated type, and has thus inaugurated a new and higher evolutionary period. In man, the unit of the present period, the builder of human societies, the psychical functions of the organic living network, latent in former periods, have been developed by interplay with a psychical environment. The mental development of man and the complicated problems of social life are thus treated as being serial with the simpler phenomena of organic life and as pointing to some future higher development of the great Cosmic Rhythm.' "

DAHLIA. See *Floral Section.*

Dates

Phoenix dactylifera

The dates of commerce are the fruit of a species of palm, a tree which ranges from the Canary islands through Northern Africa and the southeast of Asia to India. It has been cultivated and much prized through most of these regions from the remotest antiquity. Its cultivation and use are described on the mural tablets of the ancient Assyrians. In Arabia, it is the chief source of national wealth, and its fruit forms the staple article of food in that country. The tree has also been introduced along the Mediterranean shores of Europe; but as its fruit does not ripen as far north, the European plants are used only to supply leaves for the festival of Palm Sunday among Christians, and for the celebration of the Passover by the Jews. The date palm is a beautiful tree, growing to a height of from 60 to 80 feet, and its stem, which is strongly marked with old leaf scars, terminates in a crown of shining pinnate leaves. The flowers spring in branching spadices from the axils of the leaves, and as the trees are unisexual it is necessary in cultivation to fertilize the female flowers by artificial means. The fruit is oblong, fleshy and contains one very hard seed which is deeply furrowed on the inside. The fruit varies much in color, size and quality, under cultivation. Those who only know the date palm from the dried specimens of that fruit shown beneath a label in shop windows, can hardly imagine how delicious it is when eaten fresh in Central Arabia. The dried fruit used for dessert in European countries contains more than half its weight of sugar, six per cent of albumen, and 12 per cent of gummy matter.

Encyclopedia Britannica.

The Date Palm in the United States

The date was early introduced into America by the Spanish. The history and present status of the date palm in the United States has been made a subject of study by the Arizona station. The following statements are taken mainly from a bulletin of that station. The palm followed the progress of Catholic missions from St. Augustine to Mexico, New Mexico, Arizona and California, where it is now grown in the open ground as an ornament as far north as San Francisco. The tree will, however, produce fruit only over a much more limited area. It is not yet grown on a commercial scale anywhere within the United States, though occasional seedlings are found in the desert regions of Southern New Mexico, Arizona, and Southeastern California, which produce fruit of excellent quality.

The greatest impulse was given to date growing in this country by the importation by the Division of Pomology of this Department of rooted suckers supposed to have been taken from female trees known to produce fruit of excellent quality. These were distributed and planted in Las Cruces, N. M.; Phœnix and Yuma, Ariz.; Indio, Pomona, Tulare, and National City, Cal. Of the trees thus planted it appears that 39 are now living, of which 15 have blossomed, seven of them being pistillate or fruit-bearing plants. It may be two or three years before their true fruit qualities can be ascertained.

The regions in which the date palm thrives are characterized by deficiency of rain and wide variations of temperature. The summer heat is intense, reaching 115° or more, though in winter the thermometer may fall as low as 16° below freezing. These climatic conditions are practically identical with those that obtain in the more southerly portions of the great Colorado desert. So great is the similarity in fact that, so far as climate is concerned, we may reasonably expect the date palm to fruit satisfactorily in the arid regions of our Southwest. Although the date palm requires exceptionally intense heat in summer, it will withstand in winter a temperature that would be fatal to the fig or orange.

Probably the soil best adapted to the date palm is one containing a small percentage of clay, fairly free from humus, and charged with alkali. Irrigation and heat are the all-important considerations. Water is indispensable. The roots should be moist at all times. "The date must have its head in the fire and its roots in the water" is an old Arabian proverb. The water should be applied frequently throughout the year, the most in the spring before blooming and in the fall prior to ripening of the fruit. Care should be taken not to irrigate too much at the time of blooming and just after, as this is liable to interfere with successful fruit setting. The water may advantageously be quite warm, from 75° to 95°, and contain considerable alkali. In midsummer irrigation should be in the late afternoon or evening to avoid scalding.

Palms may be planted along streams or flooded basins. All desert regions are characterized by occasional depressions where the water comes nearly or quite to the surface. During the rainy season these are filled with water and sometimes do not become entirely dry before another rainy season. The date palm thrives in such spots when once established, although its trunk may be partially submerged for some time. Where irrigation is practiced, however, water should not be allowed to rise above the surface of the soil for any considerable length of time, and later be allowed to dry away, as baking of the soil under these conditions may result in serious injury to the tree. From a study of the soil and climatic conditions in Northern Africa, where the date palm flourishes, it seems probable that dates may be grown in the region adjacent to the Salton basin west of Yuma.

The date may be propagated from seeds

or suckers. The former method is not much used except in originating new varieties, because, like many other fruits, the date does not come true to seed. The fruit is generally later and poorer, and the excessive number of males that spring up cannot be distinguished and destroyed until the tree blossoms, hence propagation by suckers is resorted to, although the date is difficult to transplant with uniform success. Frequently as many as 50 per cent. of the transplanted dates die after they have received the best of care, and if neglected hardly any will survive. The Arizona station gives directions for transplanting as follows:

Suckers may be removed at any time during the spring or early summer, or even in the winter if proper care be given them after removal. If they are to be planted in the open ground, it is advisable to remove them during the spring or early summer, April probably being the best month. In winter, when the plants are at a standstill, the suckers may be removed with comparatively small loss, if the bulbs be not less than four inches in diameter and have a few roots. It is necessary, when suckers are removed at this season, to set them in rather small pots, so that the earth, which should be given a daily soaking, may have a chance to get warm quickly. The pots should be kept in a greenhouse, or, better yet, embedded in a hotbed of manure, covered with the customary frame and glass. In all cases the leaves should be cut back to six to 12 inches in length. * * *

If proper attention can be given it is best to plant the suckers where they are to remain, as a second chance for loss occurs when they are planted in a nursery and later removed to the position that they are finally to occupy.

A two-inch chisel well sharpened, and an appropriate mallet, are the important tools to use in removing suckers. The leaf stalk should be cut away, exposing the bulb of the sucker, care being taken not to injure the bulb in removing. One should cut in rather deeply at either side, not being afraid of injuring the old plant, cutting out a V-shaped portion extending from the base of the bulb downward for a foot or more and being careful to secure in uninjured condition all the attached roots. If the position of the sucker be not too high above the ground, the V-shaped portion should be continued downward into the soil, that all established roots be obtained. The Pomona substation in California has the best success in removing suckers by banking earth about the stem of the plant so as to cover the bulbs a number of weeks prior to removing them. A good system of roots is established by this method of procedure.

Male and female flowers of the palm are borne on separate plants. In the male plant the flowers are crowded closely together on a large branched panicle and have an odor like musty flour. If the panicle is shaken when the flowers are well opened quantities of pollen will escape, filling the air as if with dust. The flowers in the female panicle are much farther apart; the segments are smaller and less spreading. The center of the flower is well filled by three pistils, two of which soon become abortive.

It is evident, then, that male and female trees should be planted near each other. It is quite common to set one male plant in the center of an irregular circle of six or eight females. If the trees are planted in a row along a roadside the male trees should be planted to the windward. The wind may be depended upon as a rule to effect pollination if the staminate is not more than six or seven rods from the pistillate flowers. At greater distances pollination may be effected, though with doubtful certainty of completeness, by both wind and bees.

The palm is peculiar in that the pollen retains its fertility for a long time. It may be transported to great distances and artificially applied to the female blossom with success. Pollen should not be dusted on the flower too profusely, as overpollination is said to weaken the developing dates and cause them to drop from the tree. When artificial pollination is necessary the male blossom is cut from the tree as soon as the cracking of the spathe shows that it is about to open. The panicle may then be cut into pieces and a piece tied near the opening of each female panicle.

The date palm, whether male or female, varies greatly as to time of blooming. It always blooms late, however, thus escaping injury from late spring frosts. In Arizona the blossoming period begins about April 15 and continues six weeks or more. In planting male trees suckers should be selected from those that blossom earliest and most profusely and continue in bloom from three to five weeks.

The varieties of dates are almost innumerable. They vary greatly in size, color, sweetness, delicacy of flavor, and length of time required to mature. The dates of commerce are usually light colored, these being of firmer texture, and are hence preferable for shipping purposes.

The average yield of a tree is eight bunches, each weighing about 17½ pounds, though they may weigh as much as 44 pounds. In Arizona seedling trees seven years of age have produced upwards of 200 pounds in a single season. Young trees blossoming the first or second time should not be allowed to bear more than four or five bunches.

Among the various enemies of the date, birds and bees do much injury by feeding on the ripe fruit. Cheese cloth sacks loosely inclosing the bunches on the tree afford the best protection. The expense should not exceed 10 cents per tree. Grasshoppers do much damage by feeding on the foliage. The most serious pest that the date has in this country is a scale insect that was imported on palms several years ago. The insect is small, but conspicuous against the dark green leaves, both sides of which are infested. The Arizona station has not yet discovered any means of eradicating the pest. Applications of whale-oil soap washes and fumigation with hydrocyanic-acid gas have been only partially successful.

Office of Experiment Stations, U. S. Department of Agriculture, Bulletin 92.

Delaware

Delaware has a land area of 1,257,600 acres, and with the exception of Rhode Island, is the smallest state in the union. It has a population of 202,322, a large percentage of which live in manufacturing centers. There were reported in 1909 10,836 farms which give a fairly good estimate of the number of farmers. The average number of acres per farm is 95.6, and the average value of farm land per acre is $33.63.

The soil and climate are not much different from those of New Jersey, or any of the portions of country along the Atlantic coast. There is in the soil a considerable mixture of clay and sand with some humus, which renders it adaptable to the growing of fruits, melons, potatoes and vegetables. The waters also furnish reasonable protection from frosts. It has been supposed that Delaware was especially adapted to the growing of peaches; and some supposed it would soon become a great peach orchard; but at the time of the largest hopes in this direction, the "Peach Yellows," a disease not well understood, struck the orchards and thousands of acres of trees were dug up, while the planting was in a considerable degree checked. According to the census of 1910 Delaware had of peaches and nectarines 1,177,402 trees; apples, 429,753; pears, 449,692; grapes, 260,936 vines, and strawberries, 7,194 acres. In 1909 the production of all orchard fruits together was 65 per cent less than in 1899.

For market facilities, there is no state more favorably situated than is Delaware. Of the total value of crops in 1909, 51.4 per cent was contributed by cereals, 21.1 per cent by potatoes and vegetables, 12.9 per cent by hay and forage, and 15.6 per cent by small fruits, forest products, orchard fruits and nuts.

GRANVILLE LOWTHER

Progress in Apple Growing in Delaware

Progress in apple growing in Delaware in twenty years is from practically nothing to a respectable crop. To realize just what has been done, a comparison must be drawn between then and now.

Then a few venturous spirits had been making excursions into the unknown by planting any variety that any one recommended. Out of that hodge podge of planting had appeared some few varieties seemingly well adapted for use here, but mostly Delaware orchards were the relics of the tree agent age when the glib tongue and beautiful pictures of fruit sold trees well adapted for planting in the north but worthless for this soil and climate. Remnants of these orchards still exist in many localities. With these were found a few varieties like Winter Grixon and some of the earlier sorts, good enough in themselves at that date for local consumption, but none of them free enough of scabs, blights, rusts and worm-holes to have commercial value. Men who know, said that good, clean fruit had been grown here, but for some reason would not grow any more. No market existed for the stuff that was grown, for none were so poor as to do it reverence. When a little start had been made and more good fruit was raised than local markets could consume, it was uphill work to convince buyers for the large markets that Delaware could produce any apples suitable for their trade.

Today Delaware ranks high in production per acre and per tree; and year by year advances in quality and quantity.

S. H. Derby,

Address before 24th Annual Session of the Peninsula Horticultural Society, Dover, Del., January 10-12, 1911.

Fruit Crop of Delaware

The fruit crop in 1910 amounted to 20,000,000 quarts of berries; 750,000 bushels of apples; 500,000 bushels of peaches; 631,000 bushels of pears; 279,000 carriers of cantaloupes; 373 carloads of watermelons.

Dehydration. See *Evaporation of Fruits.*

Dewberry

The dewberry is one of the most luscious of the small fruits. It has a fine flavor, and is rapidly growing into popularity. It requires about the same care and treatment as the blackberry, but is a little more tender, and in the colder regions it would be necessary to protect the canes by a light covering of earth or straw, during the winter. Its habits of growth are somewhat different from those of the blackberry. The blackberry is an upright grower while the dewberry is a trailing vine and is usually trained on trellises.

Card, in his "Bush Fruits," doubts the value of the dewberry, and suggests that its place may be occupied with some improved varieties of blackberries. This may be true, on account of the dewberry being a poor shipper. It must be in the market not less than 36 hours after picking; but for early ripening and flavor, we have no blackberry that is its equal.

Soil and Location

In its wild state, the dewberry is found growing on light sandy soils; but experience has shown that any soil adapted to raspberries or blackberries will grow dewberries successfully.

Granville Lowther

Dewberry Culture

Propagation

The dewberry may be propagated by layering the tips or from root cuttings. In fact the plants are so easily secured that one may generally get them from his neighbors' plantation more easily than from a nurseryman. If plants are required by the wholesale a good plan is to plow a furrow along the row, place the tips of the runners in this and turn a light furrow back upon them; the tips must be actually covered. This work should be done before the opening of the picking season in most altitudes, and the plants will be ready for next spring's setting. Deep cultivation that will disturb or break large roots will cause many new plants to start. If an old bed is to be discarded, a good crop of plants may be secured by thoroughly plowing and working down the bed in the spring, allowing the young plants to spring up from the broken roots the following summer. Root-cuttings, from roots the size of a lead pencil, may be taken in the fall, stored in moist sand over winter and planted out in nursery rows the following spring. If these root-cuttings are well cared for during the winter and planted three inches deep in a good soil, kept well moistened, a fair per cent will produce plants. Root-cuttings taken in the spring and planted in the same way will also give fair results. The dewberry does not sucker as freely as the blackberry, neither does it root as readily from root-cuttings.

Preparation of Land for Planting

In an irrigated section the first step in the preparation of land for any crop is proper leveling; low spots where water settles or high spots difficult to irrigate materially cut down the dewberry yield. Best stands are secured when the ground has been deeply plowed, well worked down and pulverized; no doubt fall preparation is advisable for spring setting.

Planting

The majority of our dewberry beds are from spring settings but many of our experienced growers seem to be of the opinion that fall setting would prove as satisfactory and would bring quicker returns. I see no reason for not setting in the fall, the plants would necessarily be quite tender the first winter but could be well protected and should suffer no injury. Planting in the fall should be done in early September and spring planting as soon as the ground can be worked. As to distances for planting there is still some dispute, but, if the plants are to be allowed to grow prostrate, setting 5x5 feet seems to be the most satisfactory system. They can be pruned accordingly and cultivated either way. If grown on a wire trellis, rows six feet apart with plants three feet in the row would no doubt be a better system. When planted in the young orchard, the distance can be made such as to best utilize the space. There is no particular objection to planting dewberries in the young orchard but the grower is to be cautioned about crowding the trees and advised that in most cases it is not a crop for the old orchard.

For planting, the ground is furrowed out one way and cross-marked. The plants are dropped in the furrow at its intersection with the cross-mark, and partially covered with the foot. The furrow is turned back, the plants straightened up, the soil firmed about them, and the job of setting is completed by running water down the row. As with any other plant, the top should be cut back at setting time to offset the loss of roots in digging.

Cultivation

The cultivation of the dewberry patch should not be unlike that for any other bush fruit. It should be well cultivated in the early part of the season to keep down the weeds and conserve the moisture. Cultivation stops at the opening of the picking season and is resumed again at its close, continuing until the end of the growing season. Since deep cultivation which disturbs or breaks the roots tends to start objectionable plants in the middles, the early cultivations and possibly the later ones should be rather shallow. If the plants are allowed to run for the purpose of being trained on a trellis, cultivation must be in one direction; when checked equal distance each way the general plan is to keep the middles open only one way. While it may be possible to overgrow the plants by continual cultivation, it is better to counteract this by withholding water rather than by discontinuing cultivation. Good cultivation is no doubt conducive to vigorous, but not necessarily to rampant growth.

Irrigation

There are really no tricks in irrigating dewberries. The ground should be kept moist and in good condition during the early part of the growing season. The young plants will stand a good deal of water the first season. During the picking season it is the common practice to water after each picking, just a light surface watering. This supplies the roots with the needed moisture to swell the berries to good size and by keeping the surface of the ground moist the berries ripen better, there is less loss from the drying of the fruit. It would be a good plan, no doubt, to try to induce early maturity of the canes by withholding water after the close of the picking season. In localities where the winter snowfall is not great the dewberry patch should be given a late fall irrigation.

Fertilizing

The grower of dewberries cannot expect that the plants will continue bearing good annual crops without fertilization. If properly cared for, there seems to be almost no limit to the duration of the plantation. Good stable manure is one of the best fertilizers. It may be applied in early spring before uncovering the plants and the uncovering process as well as early cultivation will help incorporate it with the soil. Frequent light applications are preferable to heavy and irregular ones, as they tend to promote more uniform growth and yields.

Pruning

In most sections dewberries are allowed to grow prostrate; growers say it is too expensive to trellis them and it might be added that the present system seems highly satisfactory. No doubt, under certain conditions, trellising would be advisable but surely could not increase the yield any considerable amount. Where the plants are grown on a trellis, they receive no summer pruning as a rule; the new canes are allowed to trail on the ground under the trellis while the fruiting canes are tied to the wires. The only pruning the plant requires—unless it be a clipping back in August to induce early maturity—is cutting out the old canes in the fall or spring and shortening the new ones to three or three and one-half feet. A two-wire trellis is generally used, the top wire being about three feet from the ground. The training of the dewberry without the trellis requires a little more care in pruning but saves the labor of tying up and allows of early cultivation either way. The first pruning consists in tipping the new growths when they have attained a length of 12 or 18 inches; the canes then stand upright above the old wood and the tips may be mowed off with a sickle or large knife. It is important that this pruning be done at the right time; do not wait until the canes are longer and then cut back to eighteen inches or weak lateral canes will be the result. This early pruning forces out lateral canes and thus increases the bearing surface as well as stiffens the lower part of the cane, making it support itself better. The general practice is to prune the second time just before picking begins. The main object of the pruning seems to be to get the new wood out of the way of the pickers. At this time the lateral canes forced by the first pruning are cut back to two or two and one-half feet; they should be left long enough to shade the old wood and the fruit, yet short enough to be easily lifted by the pickers. This pruning must not be delayed too long as it starts new growth which should have time to mature. At its best it is not satisfactory and it is probable that the growers will yet learn to avoid this pruning. The third pruning is administered the following spring, and consists in removing all old canes and shortening in the new canes that may have grown too long. There seems to be no reason why this pruning may not be done before covering in the fall other than that the foliage makes the pruning more difficult.

Picking

In growing dewberries on a large scale one of the serious problems is that of securing pickers. The average picker will pick from five to seven crates a day, and this means that it will take from eight to ten average pickers to pick an acre per day. The general practice is to pick every third day, and the large patch may be divided so as to furnish the pickers employment every day.

The pickers must at least wear a glove on the hand used to lift the vines and most of them wear a glove with the tips of the fingers removed on the picking hand. Some growers supply the pickers with a twelve-basket carrier, or two if the pickers are fast and able to carry them. Others advocate the use of the regular shipping crate holding twenty-four baskets. A bale may be made of heavy wire bent in a way to clamp into the grooves that serve as handles in the end of the crate. Of course crates used to pick in cannot afterwards be used as shipping crates. The deck boards and baskets for the second tier are carried along and placed in position when the first tier is filled. In this way the picker carries a full crate in one hand and at the same time does not expose them to the sun for any length of time. A piece of heavy cloth large enough to cover half the crate may be tacked by two corners across the center of the crate and used to shade one end of the crate while the other is being filled. The pickers should be made to grade the fruit, and the best way is to have them put the culls in certain boxes and pay them for picking these the same as first class fruit. This plan provides a place for fruit the picker gathers and hates to throw away because it fills up. Dewberries should be picked when a full glossy black. Berries which have gone beyond this stage and turned a dull or more ashy color are too ripe to ship. The cull box is the place for overripe, dry, and poorly colored berries. Ripe berries start mold if packed for shipment.

Dewberries should not be picked when moist, as after a heavy dew or rain. Pickers are paid by the crate, thirty cents, if they pick part of the season, and thirty-five cents if they finish the season. If the grower does not protect himself in this way, some of the pickers will leave him when picking gets poor.

Yields and Returns

A dewberry plantation in good bearing will yield from three hundred to four hundred crates of berries per acre. Mr. Baldridge's patch, on four and one-half acres of ground was set in 1903. In 1904 it yielded 125 crates of berries, in 1905, 1,800 crates; in 1906, 1,800 crates and in 1907, 2,000 crates. It would probably be hard to give a satisfactory estimate of the cost of production of dewberries. The crate costs the grower 27 cents and picking 35 cents per crate, plus probably 5 cents for overseeing and crating the fruit. At present (1909) the average price paid for dewberries has been $2.25 per crate F. O. B. the nearest shipping point.

O. B. Whipple

Colo. Exp. Sta. Bul. 136.

Varieties

[Only three varieties are recommended by the American Pomological Society for propagation, the Lucretia and Mayes or Austin-Mayes having proven successful and the McDonald, which is recommended for trial.—Ed.]

DEWBERRY DISEASES

The dewberry is troubled by the same fungus and other diseases, for the most part, as the raspberry and blackberry. The reader is referred to the diseases of these plants.

Double Blossom

Fusarium rubi Winter

A disease known as "double blossom" occurs on several species of *rubus*; but has attacked the Lucretia dewberry especially. It has been reported from the Middle Atlantic states and westward to the Mississippi, having first attracted attention in Illinois.

The disease produces witches' brooms on the buds which sometimes remain green after the canes are dead. Diseased buds show larger than normal in the spring and are frequently of a reddish color.

The outer flower parts are increased in number and appear crumpled while the ovaries fail to develop fruit. Soon after the opening of the flower buds the fungus fruits and the spores falling upon young buds germinate and grow inward. The fungus remains dormant here until the following spring.

Hand picking of the diseased buds is the most practicable method of control at present known.

Reference

M. F. Cook, Delaware Experiment Station, Bulletin 93.

DEWBERRY PESTS

The dewberry is attacked by much the same species of insects as other members of the Rubus family. See under *Blackberry and Raspberry Pests*.

Diseases of Plants

Origin and Nature of Disease

All diseases originate from one of two sources. First, the nature of the organism in which the disease is located. Second, the nature of the environment, which is something outside of the organism and to which it is closely related.

Whoever would, therefore, understand disease, must know something of the organism in which the disease is located, the environment and the relations between the organism and the environment. It is often difficult to distinguish between health and disease; because of the differences between the standards by which comparisons are made. For instance, whoever has seen an oak in the Appalachian mountain range, where it is "King of the forests," and would compare it with the same species and variety found in the semi-arid bluffs of Kansas and Nebraska, would incline to the opinion that the stunted specimen of the semi-arid section is diseased. However, the short, scrubby specimen of the Central West is normal to that region and not diseased. It may be pointed out that certain specimens of that region are decaying, have been attacked by insects, broken by storms, are not properly nourished, the leaves turning yellow, and that these particular specimens are diseased while the normal specimens, with no visible decay, no external injuries and no apparent lack of nourishment, are healthy. Prof. A. D. Selby, Botanist of the Ohio Agricultural Experiment Station, says: "The idea of disease is not an easy one, though it may seem so before trying to define it. In reality, the term disease as applied to plants means any change in the plant towards reduced vigor from the ordinary behavior. To put it in another way, a plant is said to be diseased when it shows deviation from the average behavior of the plant in respect to appearance, growth, color of bark, foliage, fruitfulness, time of dropping the leaves, or length of life. In short, when the plant fails to perform those functions, or conform to those averages which have been established by observation for the species and variety in question, we say that it is diseased. Under such general definition, variegated or purple hued spots would be included, although diseased potentially rather than in reduced vigor."

In deciding the question of what are favorable and what are unfavorable conditions results obtained from experiments or from observed phenomena would be determining factors as against any theory. The best conditions would be those in which the best specimens were produced; average conditions would be those in which average specimens were produced; and poor conditions those under which poor specimens were produced. By observations of this character, it can be determined what environments are most favorable for the health and vigor of the plant. In this manner we have come to know in a measure what are the conditions best suited to the different varieties of apples, peaches, pears, plums, grapes, strawberries and bush fruits. We have by a general study of the subject, by information gathered from all available sources, from farmers, experiment stations and experts who have traveled widely, made comparisons so that there is a general ideal or standard of judging, by which plants are compared and the plants of normal growth, excessive growth and stunted or diseased conditions determined.

It would seem that a comparison should not therefore be made between the most perfect specimens and any particular individual of the species, nor should it be made between the more stunted specimens and the same individual, but with the average, for it is the great law of averages that determines the standard of any race, species or variety.

Perfection as a Standard

We have often urged that perfection should be the standard by which comparisons are made, and we still insist on this when we are trying to improve the stock. But judging in reference to diseased specimens is another matter. Perfection is defined as "Having all properties and qualities necessary to its nature, of the best, highest, or most complete kind of type, without deficiency, fault or blemish." Sometimes it is defined as "Finished, incapable of being improved upon." In this latter sense the word is never used in reference to fruits, for like most other things in nature, there is no limit to the degrees of improvement. The apple of the future will perhaps be as much better than the apple of today as the finest specimens of Spitzenburg are now better than the forest crab, from which they probably came. Perfection is therefore a relative term, in the same sense that disease is a relative term, and a just comparison can only be made with the average. That which is now considered perfection may be very imperfect in the future, and that which is now a standard of health may be considered stunted, because it may fall below the average.

Nature of the Organism and Disease

There is much more knowledge than formerly upon the nature of organisms and their adaptations to particular localities. It is understood that no two things in nature are exactly alike; but several things, like apples, for instance, are sufficiently alike so that the conditions necessary for the growth of one variety may be favorable for the growth of another variety. Still, it remains true, that the different varieties of apples are in many particulars unlike, and that the unlikeness is sufficiently marked so that conditions favorable for the growth of one variety may not be the best for another, and in some extreme cases are decidedly unfavorable. This is the reason why the American Pomological Society has divided the United States into districts and has given a list of the various fruits and their varieties that are "Successful, very successful, fairly successful and recommended for trial," in the different districts. (See page 192).

We will compare a few plants that belong to different species, rather than those of the same species, as illustrating our idea. Take celery, cress and cranberries as illustrations of plants that require a great amount of water. In a dry soil, where the sun was hot, they would sicken and die. On the other hand, almonds, sand-plums, sage brush and cacti would reach a normal condition and manifest health where the first named group would die. This is on account of the nature of the organism, which adapts one to a wet soil and the other to a dry soil. Because of this difference it would be folly to expect success in the growing of celery without plenty of water, or to expect success with almonds in a damp or sub-irrigated soil.

All Plants Once Aquatic

It is taught by geologists that in the early history of our globe the whole surface of the earth was successively covered with water, and that all vegetable and animal life was adapted to the water. With the changes that came from the shrinking of the surface of the earth, the consequent upheavals, the building of mountain ranges and the valleys between them, the subsequent draining of great basins of lakes and seas, and the consequent forming of deserts it came about that gradually both plants and animals became adapted to the many conditions existing between the extremes of water and desert. The struggle of all forms of life is for existence and the tendency is in the direction of those changes necessary to existence and to adapt the organism to a given environment. The plant that cannot become so adapted will in so far as that particular locality is concerned, become extinct. Naturally, therefore, the plant or tree that is adapted to the desert will have a small leaf surface, from which little water can be evaporated, or if the leaf surface is large as in the case of the cacti, it must have few stomata, or pores, from which the water can be taken by the action of the heat. It must also have a root system, adapted to the dry soil conditions under which it lives. Another example of the leaf formation in adaptation to the different conditions is the difference between the Indian corn and the Kaffir corn. The latter having a thick, compact leaf with few cells exposed to the air and which admits of a small amount of evaporation, lives in dry regions. For this reason certain varieties of peaches will live and bear fruit where other varieties would die, and watermelons will grow successfully where pumpkins and muskmelons would fail. It has, therefore, come to be observed, that plants have certain likes and dislikes, growing out of the nature of the organism, and that if any particular plant gets what it likes it is healthy, but if it does not, it becomes diseased.

Organs Have Become Permanent

Whatever may have been the causes of variation in plants, the facts remain that they are variously adapted, and that these adaptations are suited to all the conditions common on the surface of the earth. This has made necessary organs that mark them as different, performing different functions in different degrees, and these differences have become permanent. Therefore, unless these permanent likes and dislikes are considered, the wants growing out of them supplied and they are protected from that which they dislike, there cannot be a condition of health. For this reason it is necessary to study the nature of the organism and the nature of the environment. It is only by this means that it can be determined whether they are adapted to each other, or whether the soil, climate and general surroundings contain injurious elements. If a certain soil, for instance, contained all that was necessary to the health of a tree, but if at the same time it contained something injurious, the tree would suffer; as in the case of a man who ate a good healthful meal containing all that was necessary to his vigor, but at the same time took poison. Again, it is often true that certain chemical qualities in the soil are good in certain proportions, but taken in larger portions become injurious. This is true of alkali salts, which in a certain degree are fertilizers, and stimulate the growth and vigor of fruits and other crops, but in larger quantities, become injurious. In certain excessive quantities they kill the little hairs that form on the roots and which gather the food substances in solution, thus causing a lack of nourishment and final death of the plant. The symptoms are generally a yellowing of the leaves. If we may judge by the unfavorable conditions under which plant life has been observed to grow, we might conclude that there is life potentially in every particle of earth, air and water. In other words, that life is everywhere, and that it strives to clothe itself with whatever forms are adapted to its surroundings. Whoever has observed the growing of moss on the rocks in the desert or on a marble slab in a cemetery, must have wondered at the tenacity with which life struggles to maintain itself, and with which it strives to adapt itself to the most unfavorable conditions. Yet, it would be folly to plant a tree in the solid rock or try to grow a garden on a marble slab. We must, if we succeed, study the nature of the organism and the environment.

Health the Normal Condition

Whatever may be the cause or causes of diseased conditions in plants, we are forced to the conclusion that the tendency of life is toward health and toward a more perfect expression of its being. Among the many proofs that may be offered are the following:

First. The tendency of all plants to change, in order to become adapted to different conditions of soil, climate and whatever environment affects them.

Second. The effort to repair any injury that has been done by insects, animals, wounds, diseases or from whatever cause.

Diseases Classified

We give herewith a general outline under which diseases may be classified.

1. Secretional diseases, in which cellulose is transformed into gum, resin, manna. The effect is produced by overaction of the normal functions.
2. Diseases produced by fungi and other vegetable parasites.
3. Diseases produced by decomposition, as gangrene, or canker. These are processes of decay in which the cellulose is transformed into a muddy fluid, a brown powder, or a carbonaceous mass.
4. Diseases produced by the attack of insects and other animals.
5. Atmospheric conditions.
6. Soil and moisture conditions.
7. Light, electricity, winds and storms.
8. Crowding so that the food supply is cut off.
9. Isolation and consequent lack of fertilization.
10. Unknown causes.

GRANVILLE LOWTHER

History and Definition

Diseases in plants have existed as long as plants themselves—ages before the advent of man. Civilization and agriculture have usually developed together in all parts of the earth and it is not strange that anything that troubled or destroyed an important food plant should be observed and the cause sought. In the earliest historic records as well as in early Greek and Roman times some of the more destructive diseases of plants, like rust and mildew or blight of cereals were widely known and discussed. A special deity was recognized who ruled these phenomena and to whom sacrifices were offered.

Injury due to animals, especially insects, and to extremes of weather and unfavorable soil conditions were early often associated with their appropriate causes. It was not, however, until the latter part of the eighteenth and the beginning of the nineteenth century that the solid foundations of plant pathology were laid by the development of anatomy and physiology. The early works of Unger, "Die Exantheme der Pflanzen," etc. (1833); Weigmann, "Die Krankheiten und Krankhaften Misbildungen der Gewasche" (1839); and of Meyen Pflanzenpathologie" (1841), marked an important step forward in the embryo science of plant pathology. During this period microscopical, chemical and physiological work with plants was active. The writers of this period rather overworked unfavorable nutrition as the cause of disease. Maladies that could not be traced to visible external causes were usually held to be due to unsuitable nourishment or the lack of something in the soil. It was not believed that the fungi so often found associated with diseases had any casual relation to them. They were held to be abnormal developments of the diseased cells themselves and not independent organisms. It remained for De Bary to determine the true nature and habits of fungi and bacteria and to demonstrate their causal relation to disease in many cases. His careful work gave a great stimulus to investigation in plant and animal pathology and opened what has proved to be the most important field of the science. His two most important works are "Untersuchungen uber die Brandpilze," etc. (1853), and "Morphologie und Physiologie der Pilze," etc. (1866). Since De Bary the rapid development of the subject is well represented by the works of Hartig (1874-89), **Frank**, (1880-96), Soraurer (1886-8), **Marshall** Ward (1889-1901). The last work "Diseases in Plants," is one of the most excellent and readable expositions of the subject that has appeared.

Health and Disease Compared

That there is no defined line between health and disease is generally recognized by pathologists and physiologists. A plant continually varies in response to changes in its environment. There is, however, for each individual and for a given species as a whole a certain accustomed range or power of adaptation to each factor of its environment and to the various combinations of these factors. The process of natural selection operates to perfect this adaptive attuning of the individual and the species as a whole to the conditions under which they live. If these conditions are subject to great extremes of moisture and dryness or heat and cold, the natural or indigenous vegetation will be found, as a rule, equal to the emergency, while an introduced species, if developed under an environment not subject to such extremes, might be seriously injured or destroyed, and if the change is very unusual even the indigenous species may suffer. A moist, warm, cloudy spring may be followed by dry, hot weather and the tender watery growth be so much dried out and checked that it may be deformed and abnormal in shape, structure and size. This variation may be slight or it may be great. If it is slight it may have no appreciable effect on the vigor and growth of the plant. The leaves become a little firmer and smaller and more resistant to the hot, dry conditions, while the maturer leaves that cannot adapt themselves to the change turn yellow and fall, cut off by the parent plant. The plant is better for the change and can live under the modified conditions with greater ease and safety.

If the variation is greater, the growth of the plant may be decidedly checked, the leaves being small and many more of them shed. In still more extreme cases the tender leaves may be dried up and killed either wholly or in part. According to Hartig, "It is only when the sickly condition leads to the death of some part of the plant that we may speak of actual disease." Where a few leaves, unable to adapt themselves to a changed condition, turn yellow and fall, the leaves themselves may be diseased, but the plant as a whole is benefited by their loss as being relieved of sources of uncontrolled drain of its water supply. As the loss of leaves becomes greater, however, we pass from the extremely localized disease to a point where the whole or a considerable part of the plant is weakened, either by the direct loss of food that should be furnished by the leaves to the rest of the plant structure, or by the use of reserve food in the reproduction of lost parts. It is evident in such cases that the border line between health and disease is hard to define. The case is not much easier if, instead of variations produced by moisture and temperature, we consider those caused by insects or fungi. A few leaves eaten from a tree by some insect or destroyed by a fungus might have no injurious effect on the tree as a whole, and might even be an advantage, but as the number of injured leaves increases the tree is weakened and its life threatened. Slight doses of certain poisons stimulate the cells to more vigorous growth, acting as a tonic, while a little larger dose poisons and destroys the cell. Leaving all questions of consistency of definition, we may practically define as diseased all those conditions of a plant which directly or indirectly endanger its life or prevent normal development under given conditions of environment. Or, as Marshall Ward puts it, "We may define disease as dangerous disturbances in the regularity, or interference with the completeness or range of the molecular activities constituting normal life—that is, health—and it is evident that every degree of transition may be realized between the two extremes."

Prevention

Successful treatment of plant diseases consists in preventing the spread of the disease and not in curing the plants already affected. The tiny thread-like plants—the *fungi*—which cause diseases, grow inside the tissue of the leaves, stems, fruit, etc., of the plants, which they attack, and after they have gained entrance there it is impossible to reach them or to treat the tissue which they are destroying. These fungi perpetuate themselves by producing myriads of tiny seed-like reproductive bodies—*spores*—which are so tiny as to be invisible and so light that they float about everywhere in the air. They are thus carried from one plant to another by the wind, and where they lodge on a leaf or stem and find conditions favorable they germinate and grow. Disease is thus scattered from plant to plant and from field to field. These spores are always produced on the diseased areas of affected plants, and for this reason where it is possible to do so all diseased parts should be collected and burned as soon as the disease appears on them. If this could be done with all plants and all diseases they could be eliminated at one clean sweep. Unfortunately, some of these fungi live over in the soil or in fragments of decaying plants, which cannot be collected by any practical means. In such cases we have to resort to other means of controlling them. One way of doing this is by using disease resistant varieties. Certain individuals and certain varieties of plants are more resistant to disease than are other individuals and varieties. By planting seed from such individuals, and by continually discarding the plants which succumb to the disease, we originate a disease-resistant strain or variety. In some cases this is simple and can be practiced by any one; in other cases where the plants, such as trees, are long-lived, and we have to wait a long time for results, it is objectionable, and we have to resort to some more artificial method, such as spraying.

Spraying usually gives immediate but temporary relief. It is the method, however, to which we must resort at present in order to control the large majority of plant diseases. The principle of spraying depends upon the fact that these fungi are more delicate and more easily killed by poisons than are the plants on which they grow. The object is to use some poisonous solution which will not injure the plant that you are "doctoring," but will kill the fungus parasite, or if applied as a preventive, will prevent the fungus from entering the host plant. For instance, if a plant is covered with copper sulphate or some other poisonous solution the spores, which lodge on its leaves and stems, cannot grow and produce disease but will be killed by the poison. In this way plants are protected. In this connection, too, we can readily see the necessity for making the spraying thorough. Fungus spores lodging on exposed surfaces would germinate and grow directly into the leaf or stem, and actually undermine the neighboring surfaces, which might be thoroughly coated with the poison. So spraying in order to be effective must be done in such a way that every particle of surface of the susceptible part of the plant is covered. No possible exposed place should be left on the leaves or the fruit or the stems where the fungus could, perchance, enter.

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Saving Trees by the Use of Cement
How the Tree Surgeon Stays Decay with Cement Fillings

In our minds disease and suffering are so closely associated that we ordinarily regard the allaying of pain as the fundamental function of medicine and surgery. We are apt sometimes to overlook the economical gain to the community which the maintenance of health among its members implies. The economic factor is of course quite prominently displayed in veterinary practice, though here also there is pain to be alleviated. When we come to the vegetable kingdom the purely "benevolent" motive for medication is practically absent. This, perhaps, is the reason why we hardly class plant surgery in our minds in the same category as the treatment of human and animal ailments. But while there is thus a pronounced difference in the two fields, in most other respects they are very similar.

The plant, like the animal, is a living thing, subject to the attacks of enemies in life and ultimately to death. Like the stricken animal, also, the diseased plant is ready to receive at the hands of man beneficent medical or surgical treatment. And in plant surgery, as in the practice of the art on the human being, a species of asepsis is essential for success.

In the science of plant medication quite an important role is played by cement. This material has, in the practice of tree surgery, a definite, well defined purpose, and certain fixed methods of application. This does not mean that all trees should be treated alike. This is obviously impossible. However, there are certain principles which must be incorporated into each cavity, and these principles are the same for each case.

In order to understand the use of cement in trees we must understand the purpose of the operation and something of the life's processes of the tree. The inside of a tree is practically dormant, except the few layers of woody fibers just under the bark. The sap ascends in these outer woody fibers, and enters the leaf, where it undergoes the chemical change which produces the "tree-food." This tree-food descends just underneath the bark, building as it goes. It continues to descend and build until it reaches the tiniest roots. Thus we see a real circulation in the tree. The central tissues serve no purpose save that of physical support. If any other substance can take its place and accomplish the same result, the tree will continue to live and thrive indefinitely, provided the new center of the tree is sealed tight to the adjoining tissues and remains so. The real life of a tree is represented by the bark, the cambium layer just behind it, two, three or four inches of sap-wood just behind the cambium, the leaves, and the roots. If these parts are vigorous, it makes little or no difference whether the center is wood or stone.

The bark is a protection for the tree. Where the bark remains intact, the woody fibers of the inside are preserved for generations and for centuries, unless some outside agency kills the tree. Destroy any part of the bark by any means whatsoever, and when the protection is gone the wood decays. Once decay secures a start, its progress is rapid. It continues until checked by artificial measures or until the tree becomes so weak that it is blown over in a windstorm. The tree may appear to be in a perfectly healthy condition even with the entire inside rotted away, simply because the vital parts (three or four inches on the outside) are the last to be destroyed. Decay attacks and disintegrates the dormant tissues first, and gradually works outward. Cement in trees fulfills the three-fold purpose of stopping decay, serving as a structural support, and providing a surface over which the bark may heal.

Is cement work in trees a success? In other words, is tree surgery a real or fancied good? Does it save the trees? That depends on the vitality of the tree, and the ability of the man who undertakes the work. A man may be so nearly exhausted and so low in vitality that all the doctors in the land could not save him. A tree may be the same. If it is weak and far spent the chances are against it. If it is vigorous and healthy, the chances are all in its favor *if the man who operates knows how.* The only real test of a tree's vitality is the appearance and density of the foliage. A rich-green abundant foliage indicates health, and *vice versa.* And still almost the entire inside may have rotted away!

Tree surgery, or that part of it pertaining to the filling of cavities, is aptly comparable with dentistry. The three fundamental principles of each are the same. The dentist must remove all decay and prevent more, prepare the cavity so that the filling will stay permanently in place, and exclude all foreign substances. The tree surgeon must do the same things, although the means to that end may differ somewhat. To remove the decay from a cavity requires chisels and gouges of various lengths and sizes. The smaller cavities are not exceedingly difficult, although they require the same exacting care. The larger a cavity becomes the harder the task of removing the decay. It must be followed in the cracks and crevices and away up and down through limbs and trunk as far as it goes. It is sometimes burned out, although this measure is very dangerous unless applied by a man who thoroughly understands its use. When the decay is removed, it is wise to apply corrosive sublimate or a similar solution to destroy any remaining fungi. The walls of the cavity must then be thoroughly waterproofed to protect the wood. The waterproofing material must be durable, penetrating and adhesive. This is the first step and is very similar to the first principle applied by the dentist.

Perhaps the most difficult and trying part is in preparing the cavity so that the filling will stay permanently in place. This requires more than a knowledge of cement and its use. It requires more than a scientific knowledge of trees. It requires both these and more. The operator absolutely must know the practical methods of tree surgery, and have acquired almost instinctive skill with his hands by long practice. Cement improperly put into a tree is far worse than none. The law does not permit untrained men to practice upon the human body or even that small part of it called the teeth. Why should untrained men operate on trees which are just as much alive as human beings?

The cavity must be thoroughly braced if it has any size. No man can set down in words the manner in which this should be done, because it depends absolutely upon the size, shape and general condition of the cavity and the strength of the woody shell. The operator must determine the weakest side or point and brace it with great care. He must know what stress must be borne by the tree and insert steel ribs or truss rods to reinforce the trunk. All this must be done with a full appreciation of the fact that there will be *some* sway to the tree. Oftentimes it is necessary to put the cement in in sections, leaving natural joints which will permit the swaying without damage to the cement fillings. If the operator does not understand the swaying of the tree and guard against it, or does not where necessary build his cement in sections, all his carefully laid plans up to this point will go for naught. Unless he can keep his filling permanently in place, just as in dentistry, his work is a complete failure.

The exclusion of foreign substances, especially water, is the ultra-important task of the tree surgeon, just as it is with the dentist. If the water seeps in behind the cement filling, it is only a question of time until the condition of the tree is worse than formerly. *No cement work is a success which does not exclude the moisture.* The skilled tree surgeon prepares a "water shed" at the edge of the cavity, beyond which the moisture cannot penetrate. To make assurance doubly sure he applies to this water shed all around the edge of the opening an adhesive waterproofing material. At times it is necessary to go farther than this and cover the entire opening with a metallic shield, non-corrosive, which is nailed very tight on the top and along the sides especially. Waterproofing material is then applied on the outside.

All of this must be done with the ultimate purpose of allowing the bark to heal over the filling. Therefore the filling must be *under the edge* of the bark at every point, and the contour of the tree must be restored, so that when the bark does heal over and seal the filling permanently, there will be no evidence of the old yawning cavity save the unobtrusive scar. As surely as there is health and vigor in a tree the bark will begin to roll out and over the filling. Nature responds wonderfully to proper treatment.

A tree is a living creature! This is the foundation fact of tree surgery. It ministers to the human family in comfort, health, beauty and pleasure. It is past valuation. It makes possible the solemn stillness of the forest. It holds in check the waters that go to form the rivers and insures their continuity. It robes the hills in green and hides their gaunt and lifeless forms. It gives grace and beauty and verdant loveliness to the valleys. It shades the urban highways where masses of mankind pass to and fro. It shelters and makes beautiful the public parks, the breathing places of the people. Its contribution to the food of man is of untold measure.

A tree is a fitting companion to man. It is quite proper that the highest development of the vegetable kingdom should contribute so largely to the well-being of man. Man should in turn give it reasonable care and protection so that its period of ministration may be a maximum. Because a tree is a living organism it is subject to decay and premature death. Tree surgery is the concrete expression of man's desire to protect the physical well-being of the trees and preserve them for his own pleasure and profit, and for that of the generations to come. Real tree surgery saves trees. It is well. Thus we have another step in the advancement of man.

M. L. DAVEY,
Scientific American, March 18, 1911.

FOR PARTICULAR DISEASES. See under the *Various Fruits.*

DISTRICTS. See *Fruits Recommended for Cultivation*, under *Apple*, page 192.

Drainage

The greatest problem of an arid country is irrigation, and the next greatest is drainage, because in irrigation there must be seepage and waste that will injure and render more or less valueless the lower lands onto which this seepage and waste are drained. Very often it causes alkali deposits; or it becomes boggy so that few crops can be grown upon it.

Reasons for Drainage

First—It prevents water which falls upon the ground from remaining at or near the surface and renders the soil dry enough to be worked or plowed very soon after a rain, whereas if it is not drained, the farmer must wait for the water to seep away or to evaporate, and thereby lose much valuable time.

Second—It renders the soil porous and spongy, which enables it to take in the water easily.

Third—It prevents the adhesion or cementing of the soil, assists in pulverizing it, and allows the roots of trees or vegetables to pass easily through it.

Fourth—It assists in the mixture of the chemicals from manure through the pulverized portions of the soil, thus greatly increasing the amount of plant food available.

Fifth—It allows water which falls on the surface to pass down into the soil, carrying with it fertilizing substances.

Sixth—The temperature of the water of falling rain is generally much warmer than the subsoil of the earth, as is proven by the fact that the water drained from the subsoils is colder than the falling rain. A proper drainage system, therefore, will enable this warmer water to penetrate the earth and warm the roots of vegetables or trees, thus stimulating their growth.

Seventh—The increased porosity of the soil renders it a more perfect non-conductor of heat, and therefore the roots are kept warmer and the trees less injured by freezing in winter.

Eighth—It assists in aerating the soil, therefore aiding in the decomposition of any vegetable or organic matter in the soil.

Ninth—Farming operations may be begun earlier on account of the earlier drying of the soil in the springtime and an increase of crops is almost sure.

Tenth—It economizes labor by allowing work to go on at almost any time without waiting for the ground to become dried out after a rain and before plowing is begun. I have seen farmers with adjoining lands, one with his farm properly drained and the other not drained, and have seen the farmer with his land drained, plowing and cultivating, economizing the time and labor of men employed to work on the farm, the labor of teams, etc.; while the one by his side, with conditions almost identical, except that his land was not drained, with his hired men and teams lying idle, waiting for the ground to dry so that he could plow and cultivate.

Soil Conditions Where Drainage Is Desirable

It is better to drain where the water stands on the surface and interferes with the growing crops; where the water accumulates beneath the surface and originates springs; where there is a substratum of hardpan or hard soil that will not allow the water to pass through, but compels it to seep along on a hard surface called a water line; where they are basins or ponds that hold the water. Generally these basins are very rich in humus and under proper conditions would produce abundant crops. It is better to drain where the water flows from high lands that are being irrigated and where waters seep from higher lands. No matter whether these higher lands are irrigated or unirrigated, if there is seepage above, they should be drained. Drains are made of tile or burned clay, of concrete, or stone, or of boards, depending on the character of the soil and the choice of the one who does the draining. They are generally placed at such a distance apart as to carry off the waste and seepage water, and if the object is to open up and make porous a compact soil, they are generally placed about 2½ to 3 feet deep and 25 to 30 feet apart.

The problems of drainage in the volcanic ash soils of the Northwest are vastly different from those in the open, porous and sandy soils of some other sections of the country. This grows out of the fact that the volcanic ash soils incline to pack and puddle when the water is placed upon them and are not so susceptible to the influence of drainage systems, as are most other soils.

GRANVILLE LOWTHER

History and Principles

The primary object of drainage is to decrease the excessive supply of soil water, while in irrigation the chief object is to increase the amount of soil moisture. In either case we are dealing with moisture, and a knowledge of its forms, movements and control is of great importance at the beginning.

Importance of Soil Moisture

Of all the factors which influence growth, moisture is without doubt the most important. Plants suffer more frequently for want of proper moisture conditions than they do for want of chemical elements of plant food. Moisture is a carrier of plant food on the soil and in the plant. There is a wide range in which the moisture content will be favorable to growth, but for each soil there is a low limit at which plants wilt for want of moisture, and there is also a line of excessive wetness above which nothing but water plants will thrive. Moisture is necessary to bacteria of the soil. It gives turgidity to the plant cells and makes plant food available.

Supply

The amount of water in the soil is not always greater in the region of greater rainfall. Soil of a wet climate may dry and bake quickly after rains. The initial amount of water will depend on the rainfall, and stored supply as for irrigation. A thing that is more important is the supply during the growing season, so the amount of rainfall is not so vital as the time of occurrence. The rate of loss and the retentive capacity of the soil will modify the amount available during the growing season.

Forms

1. Hydrostatic water. This can be seen and is free to move by gravity. It is removed in drains. 2. Capillary moisture. This is held against the force of gravity by surface tension. It is the form used by plants. There is no distinct line between this and free water. 3. Hydroscopic moisture. This is absorbed by dry soil from the air.

Limitations

The maximum amount of the different kinds of soil moisture depends on texture, structure and content of organic matter.

Movements

Percolation. This is more rapid in tile after small streamlets have formed in the soil about the tile, and in coarse grain soils. Run-off may remove a large percentage of the rain. Evaporation. Most of the rain not lost by percolation is lost by evaporation. Capillarity. Relieves congested condition at the surface when water first comes to the soil. Capillarity depends on gravity, surface tension and pressures.

Control of Capillarity—Increase by Irrigation—Decrease by Drainage

We will for the present omit the methods for increasing the moisture content of the soil, and take up the methods of decreasing the water content. The three ways of doing this are:

1. *Cultivation.* We can hasten evaporation by early spring cultivation of the soil. By increasing the air circulation and leaving the soil with an uneven, rigid surface which exposes a greater surface for evaporation. Rolling a light sandy soil causes upward capillarity and increases evaporation at the surface. When rain falls on the soil it can be lost by run-off. Cultivation will check excessive run-off. It will also increase the water capacity and there will be less percolation.

2. *Growth of Plants.* Crops of any sort, weeds and cover crops will dry the soil by transpiration of the water through the leaves. This may be taken advantage of in taking out the excess water in the early spring. We can take advantage of this in the fall, when the cover crop is planted in the orchard tô take up the moisture and check the growth, so the buds will prepare for winter.

3. *Drainage.* Drainage consists essentially in the direct removal of gravitational water from the root zone of the soil by affording free passages for its percolation and flow. This is the chief means of decreasing the supply.

History of Drainage

The subject of drainage is attracting more widespread attention throughout the country at the present time than ever before. It becomes more important as the agricultural resources of a country are developed. There are over 1.000,000 square miles in the United States that must be drained before they can be utilized. Thirteen per cent of the irrigated lands of the West are already injured by alkali and are in need of drainage.

The history of drainage shows that various methods and materials have been used in the past, but we have now settled on one universal method. The first record of tile drainage is found in the garden of a monastery in France about 1620, where it was noticed that it was very fertile in times of drought, and that the quality and earliness of the fruit were very marked. Investigation revealed that tile 10 inches long and 4 inches in diameter were in the soil in such a manner as to form a drain at a depth of 4 feet. Each pipe was funnel shaped and made to fit into the next one. How early they were placed there was not known.

In 1650 Captain Walter Raleigh published a book on drainage called "The English Improved Agriculture," in which he proposed a plan of boring down into the hard sub-strata and letting the water down into the gravelly zone underneath. In 1832 the Denston system was introduced by Mr. Smith of Denston, Scotland. This was a system of clay pipes. In 1833 Smith published a pamphlet entitled "Smith's Remarks on Thorough Drainage." His plan was as follows: 1. Frequent drains. 2. Shallow depth, some 30 inches. 3. Parallel drains at equal distances apart throughout the field. 4. Minor drains should run down the steeper places and the main drains run along the chief hollow, tributary drains being provided for lesser hollows.

In 1837 Mr. Johnson, of Geneva, N. Y. introduced tile drainage on his farm. This was the first drainage system in America and is in still successful operation. Drainage has been rapidly developed in the Middle West during the last 20 years. Drainage laws and drainage machinery have helped to reclaim swampy areas in the Central states.

Box, stone and brush drains have given place to tile drains, which are now in general use. There are over 5,000 tile factories in the United States; some are very large. To make tile requires expensive machinery.

Soils That Need Drainage

Soil texture and structure. These often determine the need of drainage. Clay offers great friction to the movement of water. It has a greater water capacity and is apt to have a compact puddled structure. In retentive soils the first step in improvement is drainage. Getting out the excess of moisture assists in granulation. The addition of fertilizer will only be effective after good drainage. The order of improvement should be: 1. Drainage. 2. Tillage. 3. Manure. 4. Lime.

Soil and Subsoil

Soil is the surface strata where the bulk of plant foods are found, while subsoil is the strata on which the soil rests. It is lighter in color, finer in texture and contains less organic matter. Certain proportions of gravel and clay form hardpan. Iron or lime may cement and clay and give the condition known as hardpan.

Water Zones

There are three zones of flow of water through the soil: 1. The saturated zone or the strata through the water moves vertically to the water table. It may move by capillarity or by percolation or both. 2. Surface zone. This is the water table. In winter the water table is very near the surface, and in the summer the water table goes down to various depths, sometimes quite deep. 3. Deeper zone. Veins of water.

All soils must be drained, but fortunately most soils are more or less drained naturally. Natural drainage is much cheaper. The following are the conditions which require drainage:

1. Nearly flat lands upon which the water from the surrounding higher lands collects.
2. Areas adjacent to higher lands where the soil is of such a nature that water which falls on the upland will seep under and out through the low land, making it wet.
3. Lands inundated regularly by the rise of tides or frequently by the overflow of rivers.
4. Extremely flat lands in wide areas which are underlaid near the surface by

a thick, close, nearly impervious clay subsoil.

5. Lands like rice lands, water meadows and cranberry marshes, where water is applied excessively and must be removed again.

In general, all low-lying fine-grained soils with fine, heavy subsoil will need drainage.

Benefits of Drainage

1. Removes excessive water. 2. Increases the capillary supply of moisture. 3. Improves the texture. 4. Increases the root pasturage. 5. Affords better air circulation. 6. Makes the soil warmer. 7. Lengthens the growing season; firms the soil. 8. Assists decay and nitrification. 9. Prevents erosion. 10. Diminishes the effect of drought. 11. Prevents heaving. 12. Prevents the rise of alkali. Drainage does this and more. It pays in increased yields and land values. Road drainage aids in transportation. Sanitary drainage improves healthfulness. To what extent drainage is warranted depends on the crops to be grown.

Kinds of Drainage

1. Natural drainage. (a) Through gravel subsoil. (b) Through surface run-off.

2. Artificial. (a) Open drains. (b) Underdrains (brush, stone, box for alkali and tile).

The object of underdrains is to assist the action of gravity. Both surface and underdrains have their field for usefulness.

A. Open drains or surface drains are essential auxiliaries to tile for drainage of large areas. They remove water from the surface and also from the subsoil. The amount removed from the subsoil depends upon their depth and fall and the amount of water in the channel. Surface they are adapted to: 1. Where the volume to be removed is large. 2. Where the water table is near the surface. 3. Where the drainage is designed to be only for a short time. 4. As a supplement to tile drainage for large areas of flat land.

The efficiency of open drains depends on the surface flow of water into the channel. A double plow should be used to make dead furrows that will serve as surface drains and as temporary storage for excessive water. In order to drain the subsoil the ditch must be deep enough to permit percolation from the adjacent subsoil and the efficiency will depend on the texture and structure of the subsoil.

To be effective, an open drain must be evenly graded and have a smooth bottom and sides, and these side walls must be staple. A semi-circular form will give the greatest carrying capacity per cross-sectional area, and will have the least surface friction. Usually the bottom will be made flat, however, and will be about one-half the width of the top. The slope of the wall will vary with the soil. One to one slope is commonly used with clay, and one and a half to one for loam soils. Lighter soils will stand a deeper grade. The fall should be uniform and just sufficient to afford scouring without erosion or silting. Silt or sand is more susceptible to erosion than clay. Sedimentation will be less where growth of vegetation in the bottom is prevented.

When it is desired to reclaim and improve large areas of level land such tracts must be cut up into sections or districts by large open ditches, in order that tile drains may be laid in every part without necessitating the use of mains too large and costly to be profitable. While these open ditches are not desirable in themselves, since they occupy the land and divide the field into irregular shapes, yet they are necessary to every large system of drainage. They should be located with care, following the course of natural drainage as far as possible, with due regard to straight courses.

Construction of Ditches

A common method of making small open ditches is to use a team and scraper. This is a good method to use where the earth is dry enough to afford a footing. Contractors have done such work for as low as ten cents per cubic yard, where conditions were favorable. A large part of the open ditch work must be done in swamps, and where it is too wet to use a team and scraper.

For the construction of small and shallow ditches, what is known as the capstan ditch plow is used in some localities. This is an immense plow which makes a ditch by cutting and throwing the earth from the center each way, its action being similar to a common sod plow. There are wings which push the loose earth three feet away from the edge of the ditch, leaving it in a large continuous ridge on each side. The plow is pulled by two capstans, each of which is turned by a team of horses. The capstans are anchored ahead, and their winding drums are attached to the plow by winding ropes. This machine makes a clean ditch 8 feet wide at the top, 1 foot wide at the bottom, and ordinarily limited in depth to 2½ feet. Used in Minnesota. Contract work is taken for about $1 per rod of completed ditch. The earth should be wet for this plow to work easily.

Steam dredges are used for the reclamation of large areas, and are of three different types. 1. Floating dredge; begins work at the upper end of the channel and works towards the outlet. There must be sufficient water in the ditch to float the boat which carries the engine and excavating machinery.

The excavated earth is deposited on each side of the ditch about 9 feet from the edge of the channel. This style of dredge is adapted to the excavation of large channels, varying from 12 to 40 feet wide, and as deep as required. It has been used extensively in the Middle West. The ditch has a shape similar to the letter U.

A second type of steam dredge will make ditches 4 feet at the bottom, 12 to 15 feet at the top, with a depth of from 4 to 9 feet and a slope of 45 degrees. This machine is placed at the outlet and pulled up grade by means of a drum and cable. No water is required in the ditch in order to operate it. It is limited in its field and not much in favor with contractors.

The third type of steam machine has similar limitations. It is constructed to move up grade on the surface of the ground in advance of the excavation. The plant carrying the machinery rests upon long runners which rest upon movable rollers. The plant is moved by a cable, one end of which is attached to a winding drum at the engine, and the other to a log anchored some distance ahead of the machine, technically called a "dead man." The excavating machinery consists of two dippers which are filled by being pulled toward the machine and then dumped alternately.

The machines described have been used for 15 to 20 years. The boats are built and the machinery mounted where the work is to be done. The machines cost not less than $5,000 each. They are operated by contractors, who provide themselves with full equipment to do the work by the cubic yard, under direction of an engineer. Contracts have been taken at 6 to 15 cents per cubic yard. The larger contracts approach the lower figure. Large areas are drained co-operatively, each farmer benefited paying a share. In most states the main canal is subject to the drainage law.

The course of ditches and streams is crooked in flat land, but artificial drainage channels may improve and straighten them. Ditches on rolling land may differ from those on flat lands by having narrow bottoms, since the velocity of flow is sufficient to scour and deepen them. The outlets of tile in rolling land may be shallower where there is a marked rise in the ground surface above the outlet.

Cross-Section and Behavior of Ditches

It has been found by experience that ditches may be constructed with sides more nearly vertical than was formerly thought practicable. In stiff loams and clays it is not desirable to cut sides with slopes greater than 1-1. Loams, 1½-1. Ditches made with a floating dredge have a slope of about 1½-1. Weathering and erosion will in any case change the slope, so it is of greater importance to secure ample bottom width in order to allow this change than to attempt to make the exact slope desired and to expect it to remain.

The excavated earth, or waste bank,

which lies in unsightly masses along the edge of the ditch will, in a year or so, assume a more workable shape and can be leveled down with the plow and scraper, until the land can be cultivated nearly to the edge of the ditch. It is always well, however, to keep a strip on each side bordering the ditch in grass, to prevent crumbling of the banks and loss of soil from the adjoining field. The space between the waste bank and the ditch is called the borm, and should equal the depth of the ditch. Water will flow with a fall of six inches to the mile, but to be effective the fall of a ditch should be from 4 to 6 feet. Large and deep ditches made straight and so constructed that they will not receive silt or debris in large quantities will probably be self-cleaning, are necessary for large areas, and should be from 6 to 10 feet deep.

In many cases the entire grade for lateral drainage must be made by additional depth of the outlet. The velocity and carrying capacity of the ditch increases with the depth. Water eight feet deep will have twice the velocity of that one foot deep for the same width of ditch. This partly explains why shallow ditches make poor drainage outlets.

Capacity

The capacity depends on the area to be drained, the slope of land and the fall obtainable. See text for tables.

Velocity of Discharge

This is modified by the fall and a number of other factors. A poor ditch with a rough bottom and irregular sides will carry only about half as much as a smooth, cement-lined canal. Grass and weeds will decrease the capacity to about one-fourth. The form of ditch is very important.

Wetted Perimeter

The sides and bottoms of the ditch touched by the water are known as the wetted perimeter. Friction varies directly with this factor. The wetted perimeter should be as small as possible in comparison with the cross section.

Disadvantages

Open surface drains have several disadvantages as deep soil drains.

1. They are seldom of sufficient depth.
2. They are apt to have a small carrying capacity, due to their uneven grade and rough bottom and sides.
3. They are expensive to maintain.
4. They waste much land.
5. They greatly interfere with cultural operations.
6. They may be subject to serious erosion.

Covered or Underdrainage

This is the only complete form of drainage. Underdrains or any underground channels are constructed for the removal of water. Many kinds of materials have been used for this purpose, but in recent years they have been almost entirely supplanted by tile. Brush, stones, boards and bricks were formerly used. Underdrainage will improve the soil wherever there is not complete natural drainage.

Tile

Tile is best for underdrainage because it is the cheapest, the most durable, the easiest to lay, and finally because it will drain the soil most quickly. Box drains will last from ten to twelve years. In draining the land with red tile use well burnt cylindrical tile. These tiles, one to two feet long, are laid through the soil in one continuous line with such a grade that all water which finds its way into them will be carried by gravity to the lower end of the line, thus carrying the surplus away. The water enters the openings at the ends, or joints as they are called. The ends of the tile are placed close together in order to prevent the soil from entering, yet none too close to prevent the water from entering. The action of the tile drain in removing the surplus water from the soil is as follows:

The drain being surrounded with soil, the spaces of which are filled with water, the water in the soil flows by gravity through the crevices in the ends of the tile and passes off more or less rapidly, according to the grade with which the tile is laid. Other water of the soil takes the place of that removed by percolation. Water moves downward and laterally toward the drain, and the lateral distance through which the drain will relieve the soil of water is governed by the resistance which the soil particles offer to the flow of water among them. This process does not leave the soil without moisture, but simply removes the excess or free water and makes more room for the storage of capillary or usable water. It does not remove the free water from points below the level of the drain. The free water removed by tile drains may come from rain, or it may come from seepage.

Kinds of Tile

1. Red tile.
2. Vitrified.
3. Cement—except the very large ones—is more expensive than the red clay tile. It becomes harder as it ages, and is more durable.

The tile should be round in form, straight, and every particle of clay used in making them should be completely burned. Such a tile will last indefinitely in earth and water. Where exposed to long-continued freezing and thawing, as at the outlet, the best vitrified tile should be used. After one has become familiar with the product of a given factory, properly burned tiles may be readily distinguished by their color and by their ring when struck with a piece of steel. Good clay may be semi-vitrified by skilful burning. Porosity of the finished tile is not important, since the per cent of water that passes through the walls of the tile is very small. Vitrification is desirable.

Systems of Drainage

Mains, sub-mains, laterals.

Single, double, natural, grouping, gridiron, parallel.

The natural and grouping systems are used where the aim is not to secure perfect drainage, but rather so nearly sufficient for ordinary crops as to make the increase in yield pay a fair return for the money invested. They can be used to remove water that has collected in low places.

Compare the amount of double draining with the gridiron system and parallel system. The latter has the advantage here, but long parallel lines will require large tile, or else many junctions. The parallel system is generally the best.

Depth, Frequency and Size of Tile

Principles of Drainage—In general we should drain the land where the water collects.

1. Lay the mains in the line of natural drainage, except where a "cut-off" will be in line of economy.
2. Lay the laterals in the line of greatest slope, otherwise the water may ooze out of the tile in the upper part of its course.
3. Use long parallel laterals in place of short ones where possible.
4. Make the lines straight and with easy curves—easy to lay.
5. Bring all the land needing drainage under the influence of the drains.
6. Use the level wherever in doubt.

In addition to this, keep the water spread out. Small tile are cheaper.

Depth, Frequency and Size of Tile—These three factors are closely related and constitute the most important part of drainage. These factors will depend on—

1. The character of the soil and subsoil.
2. The amount and distribution of rainfall.
3. The topography of the surface.
4. The crop to be grown.
5. Prevalence of underground water.
6. Level of the ground water.

The system should always be arranged with reference to these conditions.

Depth

The depth must be such that water can get to the tile before it shall have caused serious injury to the crop. The drain should be near the water to be removed, and below the bulk of the roots. This necessitates that it be shallower in clay to work properly. In coarse texture soils the drains attain their full efficiency almost at once, but in dense clay there is an increasing efficiency as the soil becomes granulated and the system is established. Some silt is washed out through the tile, and tiny streamlets are formed leading to the joints of the tile. A dense clay holds its pores almost full of capillary water, which is not subject to percolation. With this condition the drain must be near the surface and function chiefly as a surface drain. Deeper drains are necessary in orchards, irrigated fields and all deep rooting crops. In general it is not desirable to lower the water table as far in sand as in clay, because there is less capillary action in the former. Place tile on the boundary of sand and clay if this is from two to four feet below the surface. This allows the water to move to the tile through the sand. Generally three to five feet will be sufficient depth, and three and one-half is the common depth. The rule in the reclamation service in draining alkali land is to never place the tile more than four feet below the surface.

Frequency or Distance Apart

The distance apart is closely related to the depth. It also depends on the texture of the soil and the amount and rate of the removal of rains.

1. *Relation of Depth and Distance Apart*—If tile placed three feet deep and 100 feet apart lowers the water table one foot from the surface at the highest point, then placing tile four feet deep will lower the water half-way between them, two feet below the surface. We could accomplish the same thing by placing the tile 50 feet apart and three feet deep. If we put the tile deeper it will draw the water further each way, and the tile can be laid less frequently.

2. *The Amount of Rain and the Time Allowed for Removing It.*—Water moves through clay very slowly, and if a large amount is to be removed in a short time the drains will necessarily be placed close to the surface, and at frequent intervals their function will be primarily as surface drains.

3. *Influence of Soil Texture.*—In clay the interval must be much less than in sand. King found that 48 hours after a heavy rain the water table was one foot higher in clay soils at a distance of 27 feet from the drain. In sand the grade was one foot in 175 feet. Then to remove the water table to within one foot of the drains in clay, the tile lines would be placed every 54 feet, while in sand the distance would be 350 feet. This is probably the extreme, and the tile would need to be larger with this greater distance. Impermeable soil will require frequent parallel drains where level. Use the regular, thorough system of drains where level, uniform soil is to be drained. The aim should be to reduce the water table a definite distance in a reasonable time after rains, and the drains must be sufficiently frequent to accomplish this.

The natural system removes water where it has accumulated in low places. Large areas are drained by single lines of tile. The tile follows the natural water course, or is placed so as to intercept the seepage. This will do where the aim is to secure only fairly perfect drainage, so nearly sufficient for ordinary crops that the increased returns will pay a fair return for the outlay.

Where in doubt, one could adopt the minimum interval and place the first line of tile at two or three times this interval. If necessary, other lines could be placed between these at a later date.

Experience with different soil conditions has given us a fairly definite distance for placing tile in given soils:

100 feet to 90 feet apart for sandy soils.
60 feet to 75 feet apart for loam soils.
50 feet to 60 feet apart for sandy loam.
40 feet to 50 feet apart for loam.
35 feet to 40 feet apart for heavy loam.
30 feet to 40 feet apart for heavy clay.
30 feet apart for soils high in iron and clay.

Size—The size of the tile depends on:

1. The amount of rain.
2. The rate of removal.
3. The amount of surface run-off.
4. The grade.
5. The soil.
6. The area drained.

There are times when the crop has taken the moisture out of the ground so that a two-inch rain will not start the tile. At other times it may be necessary to remove a large part of the rain in 48 hours. At times the water cannot pass through the soil fast enough, even though the tiles are large enough to carry it off, so that part will need to be removed over the surface.

The total rainfall in different sections varies materially. Drainage has to deal with extremes of rainfall rather than the mean. Laboratory experiments are so different from field conditions that our best deductions come from the working of drains in land of a known character. Generally, if the main drains have the capacity to remove one-half inch in depth of water from the entire tract in 24 hours, they afford what may be regarded as good farm drainage. This is the capacity of many good systems in alluvial soils. In places where no advantages can be taken of surface flow, mains may be arranged to carry away one inch of water in 24 hours.

Where several laterals empty into a main, the latter must have a capacity nearly equal to their combined flow; but it is not possible to calculate the total or relative sizes with the exactness which is possible with a pressure system of pipes. This is due to the effect of the soil, which acts as a sponge, and gives up its water gradually and to the eddies caused by joints. The greater the fall the greater the capacity.

The area of a cross-section of a tile increases in ratio of the squares of the diameters. Thus 2, 3, 4 and 5 feet tile have cross-sectional areas with a ratio of 4, 9, 16 and 25 square inches. Friction and eddies are less in large tile, so that doubling the size of tile makes the capacity more than four times as great. Longer length of tile gives less capacity, due to increased friction. In general, a 4-inch tile will drain about five acres, and should not be over 500 or 600 feet long. A 5-inch tile will drain 10 acres; 6-inch, 20 acres; 7-inch, 40 acres; 8-inch, 60 acres.

Direct Leveling

The first working principle in drainage is the finding of the differences in level of two or more points.

A level surface is one that is parallel to the surface of standing water. A water surface is not level theoretically, due to the curvature of the earth's surface. It is assumed to be level, and perpendicular to a vertical line or the line of gravity. Thus a true level line is a curved line whose points are all equidistance from the earth's center, and is apparently level.

A point is above or below another point according as it is a greater or less distance from the earth's center. This difference is called "difference of level" of two points. The height of a point is its distance above a given surface, measured on a vertical line, and is called its elevation.

Direct leveling depends on three principles:

1. That the surface of a liquid in repose is level.
2. That a vertical line is perpendicular to that surface.
3. A bubble of air confined in a vessel otherwise filled with liquid will rise to the highest point in that liquid.

In direct leveling two instruments are necessary. (1) The "Y" level, which is an instrument that can be adjusted so as to mark out a horizontal place in any direction from a given point. (2) A leveling rod, an instrument that can be used to measure vertical distances. As accessories to the work, we need a tape line, or chain, for measuring distances, and a set of eleven pins for marking points; also some flags.

Definitions

A datum line is the base line to which the elevation of every point of a series is referred.

Benchmarks are permanent objects whose elevations are determined and recorded for future reference.

Turning points are points where the bearing of the line changes, and these are marked by placing a pin in the hub stake used at this point.

Backsights are readings on points whose elevations are known. A backsight is taken for the purpose of obtaining a new height of instrument. Backsights are plus quantities and are to be added.

Foresights are readings on stations whose elevation is to be found. Foresights are minus quantities and are to be subtracted from the height of the sight line. This gives the elevation of the station road.

Laying Out a Drainage System—Records

The first thing in laying out a drainage system is to tramp over the land to be drained and find out the lay of the land and then set up some flagpoles. Just a straight stick with a cloth on top will do, if you do not have regular surveyor's poles. These are placed so that the chainman can chain the levels.

A Preliminary Survey

It may be exact or it may be taken roughly. It may be necessary to make a topographic map of the whole area to be drained. In this sort of a map put in streams, etc. After this you should decide on some definite plan. Decide on some bench mark. Then go ahead and take your level notes from which you could figure your total available fall. Should chain all the lengths in order to know accurately how much tile you will need. Then make a statement and put down how many 8-inch, 6-inch, 4-inch and 3-inch and then total up and see how much it will cost.

Contour Maps, Relief Maps

A contour line is simply a line connecting all points of equal elevation. To make a contour map take the elevation of every certain distance, say 100 feet. This distance is regulated by the topography of the land to be drained. Sometimes make a topographical map and then below make a relief map. Every farm subject to drainage or irrigation needs to be provided with a contour map. Such a map will show the proper location of drains or irrigation ditches.

Profile Maps

These show a cross section of the strata through which the line of tile is to pass. They will show you the depth to be dug at each station. In preparing profile maps use a scale of four feet to the inch vertically, and 100 feet to the inch horizontally. The tile line should be in red ink.

Permanent Map

Plane table. The permanent map should be accurate so that in after-years it would be possible to go out in the field and locate the drainage system or any part of it immediately.

Details of Drainage

The bearing of the line is the angle which it makes with the magnetic needle.

Length of Laterals

This should not exceed 800 or 1,000 feet for 3-inch tile and may be 2,500 feet for 6-inch tile.

Amount of Fall

Fall is the common term for slope of land or for total head when applied to drains.

Available fall is the fall that can be given to a drain in a prescribed distance, and may be greater than the fall of the surface.

Grade of a drain is the rate of fall expressed in decimals of one foot per 100 feet. A uniform grade is simplest, but it is often necessary to change the grade. When this is done it is best to change from a less to a greater grade. A change from a greater to a less fall would check the velocity and cause silting of the drain. If it is necessary to change the grade, it is a good plan to use a silt basin.

Silt Basins

Silt basins are small cisterns in the drain extending to the surface and affording a means of cleaning out the silt. They help to collect flood water quickly. They prevent the drain from being clogged and becoming silty. They may afford watering places for stock. In a small drain a large 12-inch tile may be used by standing on end. Larger basins may be used made of brick, or boxed up with wood, and should be three feet in diameter, so that a man can enter and clean out the silt.

Collars

The use of collars is obsolete. Gravel or straw may be used in heavy soils where convenient, to allow water to enter tile more readily. The big problem in clay land is to get the water into the tile, as it does not draw well, so sometimes gravel is put in. This will help for several years, but in a volcanic ash soil or in heavy soils it will become silty.

Junctions

Laterals should enter the main at an angle of 45 degrees, and with a slight fall. It is then less likely to clog up, and is not so likely to back up and become silty. Sometimes the drop will only be one-tenth of a foot, sometimes more.

Sinks

They are useful in ponds where there is a layer of hard clay underlaid with sand. They are made by simply digging a small well (probably three feet in diameter and 12 feet deep) down through the clay to the sand to let the water through. Sometimes this is all the drainage that is necessary.

Surface Vents

They may be on the order of silt basins or catch basins. Surface vents are used to catch surface water. Surface vents are also used to afford ventilation in close soils.

Outlets

Outlets are very important. It is necessary to have a good outlet. Where the outlet is submerged and the velocity of the outflow is checked, sediment is apt to collect and clog the drain. The water should have a free spillway at the outlet. Vitrified tile, wood or masonry should be used at the outlet where the drain is exposed to frost.

Obstructions

The principal obstructions to tile are: 1, Small animals. 2, Roots. 3, Silt. The outlets should be protected with screens to keep out small animals. A good screen is made by a ¼-inch iron rod set one inch apart. The roots of such trees as willow, elm, larch, tamarack and soft maple are troublesome. Also alfalfa and grapevine roots. Trees within 15 or 20 feet of the drain should be girdled or cut down. Silt will be less troublesome in large tile. Small tile must be laid true to grade to prevent trouble. To locate obstructions dig holes in several places over the tile. When below the obstruction we find the water will fall away into the tile; above the obstruction it will stand in the hole.

Digging, Laying to Grade and Covering

Ditching Tools—Their Uses

Tile spading for removing the first spading is 18 inches long, concave, with a square cutting end. It is important that the ditch be started properly, so that the sides are plumb and smooth. The beginner makes harder work and less progress by cutting the spadeful too thick. Cut one inch and dovetail at center. A three-foot ditch should be started about nine inches wide. The common round-pointed shovel may be used to remove crumbs from the bottom of first spading. Leave crumbs till last in dry weather. The second spading is removed by use of a spade about 16 inches or less in length, concave with rounded cutting edge. The second spading should go to within one inch of the grade line. Crumbers are used to remove crumbs from the last spading and bring the ditch to grade. They are concave, semi-cylindrical, with rounded cutting blade at either end. The handle may be set at any angle. Can get 3-inch or 6-inch size. Man with crumber should keep near the one who is laying the tile.

Tile Hooks

Tile hooks are used for smaller sizes of tile, and are a great aid to rapid work where the tiles are cylindrical and the ditch is carefully prepared. A good hook should be less than a right angle, and may be made by running a 10-inch bolt through the pole about two inches from the larger end. The pole should be a little larger than a rake handle, and the end may be used to tap the tile firmly into place.

Laying to Grade

This may be done by use of a line, by use of targets, or by use of line and frequent cross lines.

Difficulties

Quicksand—caving in.

Laying Tile

In laying tile take advantage of imperfections in tile and make them fit the joints tightly. Keep true to grade and in a straight line or use easy curves.

Covering

As soon as it is inspected, blind tile. The ditch may be filled with a plow, using long double tree where no crop is growing. Plow may be used to open ditch where it will not interfere with crops or surveyor's stakes.

Drainage of Farmyards, Buildings and Road—Septic Tank

Road Drainage

Drainage is the foundation of good road construction. The surface must be crowned. Use frequent culverts and passages to fields and avoid letting the water accumulate so that it has much erosive power. Use "water breaks" on hills to throw water to side of road. Keep the surface smooth and with a 1 to 20 slope to the exact peak of the road, not rounded. Side ditches should have flaring sides, 1 to 18 slope on side of hills. Protect the side of the ditch from erosion by paving the bottom with stone or brick.

Sub-Drainage

A good road must be thoroughly drained, and artificial drainage should be provided in low, wet places. Get rid of the water in the foundation of the road before frost. Three-inch tile with a fall of 3-10ths of a foot per 100 feet—cross drains.

Barnyards, Buildings, Etc.

There should be a ditch around the farmyard to shut out any water that might run in from the outside. Have the feed floor slope gradually to a catch basin and carry the water below. Water from eaves should also be collected and carried to a catch basin. This basin should be large enough to check the water and allow the silt to settle. The inlet must be protected by wire grateing. Drain around all basements.

Septic Tank

Waste from farmhouse and from the other buildings can best be handled by means of a sanitary septic tank. A tank 3x5x6½ feet is large enough for a farm or for 10 or 11 persons.

The liquid as it passes out is free from disease germs, and it percolates away from tile to soil.

In close ground it may be well to put a load of gravel along in the trench before laying the tile. The capacity required per person is about four cubic feet. The tank need not be more than 20 feet from the house. Sewage contains about two parts per thousand solids. One of those two parts is mineral matter, the other organic matter. The mineral matter will not dissolve or decompose, and so a manhole is provided at the top for cleaning out about once a year. The liquid leaving the tank should be almost odorless, but in order for this to be so there must be no strong currents in the tank. The inlet should have but a moderate fall, one inch per rod. In cleaning out, do not remove the scum, as this contains the ferments, causing decomposition of the sewage.

Materials for the Septic Tank

Gravel, 2½ yards; sand, ½ cubic yard; cement, 3½ bbls.; lumber for form; tile at outlet, 50 feet; vitrified brick, 60; sewer tiles; labor.

The cost complete is $30 to $35.

Special Drainage Problems

Muck Lands

These lands part with their moisture easily and may become too dry. They settle when drained. Open ditches four feet deep and 200 feet apart, or tile drains 150 feet apart will in general be about right. Because those soils part with their moisture readily they may be drained very successfully. Frequently cranberry marshes will not need to be thoroughly drained, but drained part of the year.

Drains to Prevent Erosion

This is frequently a special problem. On hill sides use open ditches of moderate fall, or underground tile lines. Plow the ground so as to have terraces running around the mound and check the run-off.

Salt Marshes

These are problems that need special attention. To drain salt marshes dyke the tides out and then collect the water in surface ditches. This will generally require an engineer. Select land that is close to a market. Should be governed by the location of the land, its nearness to market, as to whether it will pay to drain. Locate the dykes so that the drains will discharge at low-tide. These dykes should be high, strong and wide, and provided with tide gates. Then the drainage area should have main drain and laterals leading to it. The rains and drains should remove the excessive salt in a couple of years, during which time the land may be pastured. Sorghum or rye may be used for the first crop. Cost of draining such lands will be about $30 to $60.

River and Creek Bottoms

Straighten the stream, dyke the upper part of the flat lands necessary, clear the river channel of brush, deepen it if necessary, clear the land of organic matter where the dyke is to be built. The slope of the side walls will depend on the character of the soil. They ought to be three feet above the high-water mark. They are ordinarily six or eight feet wide on the top. Sluice gates are necessary so that you can let the water out when necessary.

Drainage of Irrigated Lands

About 13 per cent of all the irrigated land in the United States, or about one million acres, is in need of drainage. The reason for this is the excessive use of irrigated water. The first appearance of excessive water is the appearance of swails and swamps, and later on white and black alkali, brought to the surface. The water table rises, and when it reaches to within several feet of the surface the alkali or soluble salts rise to the surface, the water evaporates and leaves this deposit of salt. (See next article.)

Remedy

The best remedy is to drain the land. Lower the water table to about four or five feet below the surface. The seepage from above should be intercepted and removed by a deep cut-off ditch. Use a second ditch if necessary, and then tile below as needed. The size of the drain depends on the area above. It may be necessary to line the canal in places where the soil is gravelly.

Kind of Drain

It should be four to seven feet deep and may be open ditch. Box drains are often better than tile. Use the larger size, never less than five inches. Box drains should never be less than 6x6 inches, while 10x12 or 12x20 inches is often used. Tramp the dirt back into the trench and watch surface irrigation water to prevent it from entering the tile.

Obstructions are more frequent in irrigated land. Alfalfa roots have been cleaned out by dragging brush and wire through. Should leave a manhole to the tile every 500 feet.

Arid soils are not full of water crevices and water moves in special underground passages. In planning for a drainage system, the first thing is to study underground conditions and lay drains to the water.

Cost of Drainage

First of all, we must know the number and size of tile required before we can make any definite estimate.

Items of Expense

1. *No. of Tile*—Lay direct to source of water and use no more than is necessary.

2. *Cost of Tile*—3-inch, $16 per 1,000; 4-inch, $20 per 1,000; 5-inch, $30 per 1,000; 6-inch, $40 per 1,000; 8-inch, $60 per 1,000. (Of course, the price of tile will vary at times and in different localities. The prices given above are for the local market.)

3. *Freight if Shipped*—3-inch tile weighs 4½ lbs.; 6-inch tile weighs 11 lbs. The cost of freighting tile is about 10c per 100 lbs. This is for small quantities.

4. *Hauling and Distributing*—3-inch tile will run about 400 to the load, and 6-inch tile about 175 to the load. Cost about $5 per team.

5. *Digging and Laying*—$2.50 to $3.50. Considerable tile has been laid in this vicinity for 40-60c per rod. This includes filling the ditch.

6. *Laying out and superintending*, 5 per cent.

Tile required per acre if laid parallel and 50 feet apart will be 872 feet. Calculate the cost of such thorough drainage per acre of 4-inch tile.

Benefits

1. *Cause Firmness and Fineness of the Soil.*—The excess of water recedes from the surface and takes its place lower in the soil, soon leaving a firm surface, which can be passed over by teams or live stock without injuring the texture. The fineness of the soil is increased by percolation.

2. *Permits Earlier and More Timely Cultivation.*—The water from rains and thawing ice passes down through the soil, admitting warm air and rains, so that the surface is ready for early plants much sooner than wet soils.

3. *Produces Aeration of Soil.*—The interspaces of soil becoming relieved of water are filled with air which carries fertilizing gases and furnishes oxygen to the roots of the plants and for the support of soil bacteria.

4. *Increases the Temperature of the Soil.*—This is explained in King's book on "The Soil." If we allow the surplus water to drain away from the field rapidly, rather than to hold it there until it has time to evaporate, it will greatly favor the warming of the soil.

5. Prevents a large waste of fertility by surface washing.

6. Increases the depth of the soil.

Approximate Prices and Weights of Tile

Size in inches	Price per 1,000 feet	Weight per foot in pounds	Average car-load in feet	No. of feet per ton
3	$ 16	4½	7,500	400
4	20	6½	6,500	334
5	30	9	5,000	250
6	40	11½	4,000	182
7	50	14	3,000	143
8	60	18	2,400	111
10	90	25	1,600	80
12	120	33	1,000	60
14	150	43	800	56
16	190-220	62	500	36
18	265-300	80	400	27
24	450-526	120	300	18

F. E. Jones,
New Westminster, B. C.

DRAINAGE OF IRRIGATED LANDS

Walter W. Weir
Drainage Engineer

The drainage of irrigated lands has become a problem whose magnitude almost equals that of irrigation itself. Fully 30 per cent of the irrigated land of the United States could be benefited by drainage or by some of the preventive measures which are used to stop seepage from canals and laterals.

Probably the most important reason why irrigated land needs drainage is that irrigation is an unnatural condition for most of the irrigated soils. These soils have no natural drainage, the capillary drainage channels that are found in the soils of humid sections are often entirely lacking because there has been no water to form them. The soil does not adjust itself to these conditions readily and consequently artificial drainage is necessary.

Another reason for irrigated lands needing drainage is that often very large amounts of water are used in a comparatively short time. It is not at all unusual to learn that 5 to 10 or even 15 acre feet of water are being used during a single season. Only a very small part of this is actually used in the growing of plants and the remainder either is lost by evaporation or seeps into the ground probably to appear at some lower level.

A third cause for damage is the presence of hard-pan streaks in the soil which prevents the percolation of water in the directions it would naturally take. These impervious strata may hold the water table so close to the surface that damage is done or it may form pockets which collect water, or again it may form a passage for the excessive seepage of a canal or lateral.

All soils in arid regions contain alkali to a greater or less degree depending on the degree of natural drainage which the soil has. Gravelly soils which have better drainage than the deep volcanic ash soils seldom develop bad alkaline conditions such as are often found in the deeper soils. Alkali is a broad term used to cover all of the injurious salts, the most common of which are the sulphates, chlorates and carbonates of calcium, sodium and magnesium.

An accumulation of alkali on the surface of land is not the cause of the land being unproductive, but is rather the result of a high water table which is the primary cause for the unproductiveness.

The surface accumulation of alkali being a result rather than a cause, the only permanent method of removing it is to remove the cause, namely the water, and this can be done only by some method of drainage. Alkali being readily soluble in water is brought to the surface by capillary attraction and is deposited as the water evaporates. If then the ground water can be kept in the ground deep enough to prevent its evaporation from the surface there can be no alkali deposited. This depth depends upon so many things that it is difficult to specify exactly what it should be. In coarse grained soils such as sand or gravel water will not rise from as great a depth as in the finer grained soils such as the ordinary volcanic ash of the arid regions of Washington. The condition of the surface of the soil also has its influence on the rise of ground water by capillarity. The water can stand closer to the surface without injury on land that is well cultivated than it can on land whose surface is hard and compact. Land growing crops which shade the land, such as alfalfa or clover, are less subject to alkali than land which is bare. Under ordinary conditions and in soil similar to that which is ordinarily found in the Yakima valley, the ground water should never be allowed to come closer than five and one-half or six feet of the surface.

One of the fundamentals of drainage in irrigated sections is not only to take off surface water but to maintain a water table below the limit of capillarity and to do this it is generally necessary to have drains at least six feet deep.

The gridiron system of tiling which is used in the humid sections is seldom employed in irrigated sections as the water generally comes from some definite direction and can be intercepted or cut off by drains located so as to catch the water before it reaches the land.

It is very essential that the individual tract to be drained be carefully studied as to subsurface conditions. By this is meant that a drainage system cannot be accurately planned without a definite knowledge of where the water is coming from, the location and depth to hard-pan if there is any, the nature of the subsoil, whether sand, gravel or loam and the nature of the surrounding land, whether irrigated or dry, flat or sloping.

In gravelly soils or soils with a gravel subsoil it will be almost universally found that the water is traveling in the gravel and that such lands drain readily and for a considerable distance from the drain. On account of the distance that this kind of land will drain the principal difficulty is in determining the amount of water which it will be necessary to handle.

In land which has a hard-pan stratum or strata beneath the surface, the difficulties are increased. It may be found that water is traveling on top of the hard-pan or it may be beneath or both above and below. If the water is below the hard-pan it is often found that it is under slight pressure and is forcing its way up through the hard-pan. In such cases drains located so as to cut through this strata will often relieve the pressure and carry away the excess water. When the water is found to be on top of the hard-pan some method of intercepting it should be planned. It is not always possible to reach this water at the proper place and depth to give relief, and it must pass too close to the surface before reaching the drains.

Dynamite has been used to break up the hard-pan strata so as to allow a freer passage through the soil, where it is closer than three or four feet to the surface. It is seldom that by dynamiting the land alone relief can be secured, as there must be some means provided whereby the water can escape. Hard-pan can be successfully broken by exploding from one-half to one stick of 20 per cent stumping powder at intervals of 15 to 25 feet. The depth and distance apart should be governed by the depth and thickness of the hard strata.

Attempts have been made to rid land

of alkali by flooding when no under drains are provided. This method can never give more than temporary relief and may do a great injury. It should always be remembered that alkali is very soluble in water and that the first water which touches it will dissolve the salt. When flooding is resorted to the first water added sinks into the ground carrying the salts down with it. The more water that is added the deeper the alkali is taken and the farther away it is from the very water that is expected to remove it. The black stain that is seen in the water used for this purpose is not all alkali, but is largely humus and vegetable matter from the soil and should not be removed. Aside from removing some humus the already high water table in the ground is raised and conditions will soon be worse than before. If, however, the land is provided with underdrains the water which sinks into the soil is taken up by them and carried away, taking with it the alkali. This then suggests a means of removing the surface alkali from a tract that is provided with underdrains.

To remove the surface alkali from a tract provided with underdrainage it should be irrigated freely to carry the alkali down and cultivated so as to retard evaporation from the surface which prevents it from returning. If it is desired to raise a crop on this kind of land a crop should be chosen which requires considerable water and constant cultivation. There are difficulties encountered in the installing of drains in volcanic ash soils that are not found in most humid sections. This soil when saturated with water becomes very difficult to handle as it flows into the ditch or trench almost as fast as it can be dug out. It is quite often necessary to line the trench with sheeting before any work can be done in it. This is accomplished by digging down to the surface of the semi-fluid soil and from there driving down sheet piling of either lumber or metal. These must be made very tight and driven from two to five feet below grade. It is nearly always necessary to construct some kind of a box or flume in the bottom of open ditches which are constructed in this soft material. After a drain has been in place for a time the soil becomes settled and the drain can be deepened or the box removed.

On account of the fineness of the soil it is best never to use tile of less diameter than four inches, and six is often better. The soil entering a three-inch tile will soon fill it up, while the larger sizes can be cleansed by flushing. The small sizes are much more likely to be displaced than the larger and their efficiency decreased.

In summing up the drainage situation in irrigated sections the secret is to know your conditions and then proceed with a definite knowledge of what is going to happen. In this way costly failures may be avoided and successful systems installed.

DROPPING OF FRUITS. See under *Fruits. Setting and Dropping.*

Drought

Curious Benefits

Drought is dreaded by farmers and gardeners because it injures grass and grain, fruits and flowers; but scientific observers testify that it brings, as a compensation, subtle gifts which enrich the soil and increase future crops.

Nature has stored in the earth a rich supply of phosphates, silicates, carbonates and other chemical salts essential to vegetable life. Those on the surface of the ground are soon exhausted, and the large supply at greater depths is often unreached by subsoil plowing.

But a drought is nature's subsoil plow to bring up the rich nutriment below. When the surface is parched, the sun draws moisture from the deeper soil, and this moisture brings with it, in solution, salts of lime and magnesia, of potash and soda. The moisture evaporates, but leaves the salts for the use of plants and grain.

Drought, therefore, does a double work. It parches the surface and lessens the present crop. It forces up rich nutriment from the deeper soil and enlarges future crops.

Drought in Middle West

In the Middle West perhaps no one thing causes greater loss to the fruit grower than the lack of rain when needed. Any method of treatment, therefore, which will enable us to mitigate this effect, even in a small degree, is well worthy of our most careful attention. How then shall we treat our orchards in order to retain for the use of the trees the greatest possible proportion of the rain which falls upon and among them? It is simply a question of evaporation, and whatever prevents the evaporation of water from the soil is a benefit to the tree and an aid to fruit production. The means of preventing evaporation which naturally suggests itself first is some kind of a mulch to cover up the soil. protecting it from sun and wind, and thus keep it from drying out. But how are we to secure such a mulch? To cover the ground with straw or any other coarse material to a sufficient depth to properly protect it is a tremendous job and very expensive, when we come to consider both the value of the material and labor of applying it. Moreover, there is a disadvantage in a mulch of that kind, in that it induces the roots to run near the surface, thus limiting the area from which they can obtain their fertility and rendering them unusually subject to injury from drought in the future should the mulch at any time become deficient. Strange it is how many of our lessons we need to learn through the teaching of what seems a misfortune. We mulch our corn fields, not so much because we want to, as because we have to. Why? Because Dame Nature has filled the soil with a multitude of weed seeds which spring up and grow so vigorously that they practically choke down the corn unless we destroy them. To rid the ground of these weeds we must cultivate, and in doing this we leave a layer of loose mellow soil on top of the ground, which is really the most satisfactory mulch we can get. It needs to be often renewed to be sure, for every shower packs it down so that to a certain extent it loses its value as a mulch. It is only when it remains light and mellow that it serves this office as it should.

Here then is the key to the solution of the problem, namely, frequent surface cultivation at least every ten days or two weeks throughout the season. In some experiments reported by Professor Roberts, of Cornell University, the daily evaporation from soil in a warm room, but not in the sun, was found to be at the rate of from one to two tons of water per acre less from portions stirred to a depth of one and one-half inches every day than from that not stirred. The difference varied greatly with the kind of soil. * * *

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Dry Farming

We have a good deal of literature published now on the subject of dry farming. Really there is no such thing as dry farming, for no vegetation will grow without moisture. The terms are comparative. In all of the so-called dry farming districts there is more or less of moisture, generally about 15 to 20 inches of rainfall per annum. The question is, how to conserve this moisture so as to profitably grow crops, especially those crops that are necessary to support a farming population with a fair percentage of merchants, mechanics and the classes that depend upon the farming population for a living. In so far as our interest in the subject is concerned, the question is, how to grow fruit. We are not treating the general subject of agriculture, we are treating the specific subject.

There are a great many places in the United States, where by proper cultivation and by the proper selection of trees that will grow fruit with the least possible amount of water, the farmer could have at least a home orchard, or in some instances might produce commercial fruits. The almond requires very little water; certain varieties of peaches and plums will grow on comparatively arid soil. We have seen plums growing wild in some arid districts where there was not more than 20 inches of rainfall per annum. Then among the apples perhaps the Wagener and the Grimes Golden will grow successfully with less water than most other varieties.

Volumes have been written upon the subject. Professor W. C. Palmer, of North Dakota, has produced what he calls the "Ten Commandments of Dry Farming." They are given here as he has written them, because they seem to condense into very small space nearly all the information that we have ever seen on that subject:

I. *Thou Shalt Plow Deep.*

- Lets rain get into soil easily.
- Lets in big rain without run off.
- Provides more feeding space for plant roots.
- More plant food made available.

II. *Thou Shalt Keep the Surface Soil Loose.*

- Keeps soil moisture from evaporating.
- Lets rain get into soil easily.
- More plant food made available, due to more moisture.
- Harrow the grain after it is up two inches or use weeder.

III. *Thou Shalt Cultivate Level.*

- Level soil has the least soil exposed to the air.
- More evaporation from a ridged soil.
- Level soil will take in rainfall much faster than ridged soil.
- On ridged soil the rain runs off through furrows.
- The soil in the ridges dries out so that the plant has less moist surface soil to draw on for food and moisture.
- Ridging the soil is a most effective way for getting rid of both the moisture in the soil and of rainfall.

IV. *Thou Shalt Summer Fallow When the Rainfall Is Less Than Fifteen Inches.*

- The summer fallow saves up two years' rain for one crop.
- The summer fallow kills weeds and plant diseases.
- The summer fallow should be cultivated.
- When rainfall is over 15 inches corn will be as good a preparation for a crop as the bare fallow.

V. *Thou Shalt Add Organic Matter to the Soil.*

- Holds moisture and plant food.
- Improves mechanical condition for the soil.
- Helps make plant food available.
- Lessens drifting and blowing of the soil.
- Lessens washing of the soil.
- Stable manure is the best form.
- Plow weeds under when green.

VI. *Thou Shalt Keep Down the Weeds.*

- Weeds use up moisture.
- Weeds use up plant food.
- Weeds crowd the plants.
- Weeds shade the crops.
- Weeds make it difficult for the plants to grow.
- Weeds make it hard to work the land properly.

VII. *Thou Shalt Grow Early Maturing Crops.*

- Growing conditions best in early summer.
- Winter grains better than spring grains.

VIII. *Thou Shalt Grow Corn Every Three to Five Years.*

- The cultivation given corn saves moisture.
- The cultivation given corn kills weeds.
- The cultivation given corn kills plant diseases.
- Corn best preparation for a grain crop.
- Corn produces fine stock food, both grain and fodder.
- Corn produces more per acre than other crops.
- Do not hill up the corn, as this wastes the moisture.

IX. *Thou Shalt Grow Clover or Alfalfa Every Few Years.*

- Clover and alfalfa add fertility to the soil.
- Clover and alfalfa add organic matter to the soil.
- Clover and alfalfa kill weeds and plant diseases.
- Clover and alfalfa produce a most valuable hay.
- Clover and alfalfa produce very valuable seed crops.

X. *Thou Shalt Keep Stock.*

- The most profitable way of marketing grain and fodder is through stock.
- They produce manure, which is very necessary to the soil.
- They bring about prosperity.

Some Misconceptions Concerning Dry Farming

"The following misconceptions concerning dry farming may be mentioned as among the most serious: (1) That any definite 'system' of dry farming has been or is likely to be established that will be of general applicability to all or any considerable part of the Great Plains area; (2) that any hard and fast rules can be adopted to govern the methods of tillage or of time and depth of plowing; (3) that deep tillage invariably and necessarily increases the water holding capacity of the soil or facilitates root development; (4) that alternate cropping and summer tillage can be relied upon as a safe basis for a permanent agriculture or that it will invariably overcome the effects of severe and long-continued droughts; and (5) that the farmer can be taught by given rules how to operate a dry land farm."

E. C. CHILCOTT,

U. S. Department of Agriculture Yearbook 1911.
E. S. R. 27-6.

DRY LAND FARMING. See *Apple Orchard, Cultivation of.*

DUTY OF WATER. See *Irrigation.*

DWARF APPLE. See *Apple, Botany of.*

EASTERN APPLE. See *Apple, Botany of.*

Education in the Common Schools

Agricultural

In an article of this character for a work on horticulture, we are necessarily more or less restricted to those portions of the subject which relate to our work and the purpose for which it is published. However, in order that we may have a proper setting for that department of the subject suited to our purpose, it is pertinent that we should outline the subject of education and then perfectly treat that part of the subject which is adapted to our work. In a general outline, we have seen nothing that seems to us clearer and more logical than that by Herbert Spencer, who says that a child should be taught to avoid the dangers of many kinds through which he must pass in order to live. These dangers imply the perils of accident, diseases, temperature, climate, environment and all those things that might affect the organism unfavorably. Second, he should be taught those things that pertain to self-sustenance. He should know how to provide for himself and not be dependent upon the intelligence and the labor of others for those things which are necessary to sustain life. Third, he should be taught those things that pertain to social relations, of marriage, the family and society in general, and be able to meet the conditions necessary in order that he may act the part of a good citizen. Fourth, he should be taught those things that tend to unfold the mind, develop and strengthen the character and that tend to the refinements of life.

This is not quite a complete outline of Spencer's "Philosophy of Education," but it gives the main points and seems to cover the ground so thoroughly and to be so clear that we have adopted it here. Now, in relation to education in agriculture or horticulture in the public schools, we are confronted with that question in a very practical way in that it is being carried on throughout the whole country. On the question of vocational training in the public schools, students are being taught home economics and mechanics. Boys are taught how to handle tools in carpentering and various other things relating to those occupations which they will probably follow when they grow up to manhood and are charged with the responsibilities of life.

In ancient times and during the Middle Ages, education was for the most part the privilege of a few persons, mostly of the aristocratic classes who ruled the masses and these masses were kept in ignorance. With the growth of the democratic and republican ideas of government, there has grown up a tendency to educate the masses, and to do so at the public expense. Under the old system of education, emphasis was given to the classes. Probably this was true in part, because science did not occupy the broad field which it has come to occupy with the new discoveries of truth through the means of the telescope, microscope and other instruments used for investigation and discovery. Now that science is so large a part of the sum total of human knowledge, and that it is so important in order to succeed in any particular calling or business, it is necessary that the student should know many things that years ago were not a part of human knowledge.

We must educate in chemistry if our pupils would fairly understand many of the things with which they have to deal, practically. There must be some knowledge of bacteriology if we are to intelligently control many of the diseases that affect our crops. We must have some knowledge of plant physiology if we are to know the laws of plant life and succeed in the highest degree in the growing of crops. We must have some knowledge of climatic conditions and the adaptations of different kinds of crops to climates. We have come to know that no particular department of work and no particular law exists alone but all things are inter-related. It would seem proper in an agricultural country, that the students in the public schools should be taught those things that pertain to agriculture or if we particularize in horticulture, it would seem proper that they should be taught those subjects which relate to the dominant industry in the community in which they live. There is greater probability that the son of a farmer will be a farmer, provided the farm can be made to pay, than that he will follow any other vocation. In like manner, there is greater probability that the son of an orchardist will be an orchardist, provided the orchard can be made to pay, than that he will leave the orchard and go into some occupation with which he is not familiar. Considering the importance of agricultural subjects, using the word agriculture in the broad sense to include horticulture, it would seem entirely proper to teach in the public schools those things that relate to the most important industry in the world, and this is more especially true when we come to consider that in the teaching of those subjects, we are giving as good mental discipline, as good training, and as large an information with reference to the things of life as could be given in any possible course of education that can be pursued, and that in so far as it concerns self-sustenance and the sustenance of those dependent upon us, it is much more important than the classical courses that have generally been mapped out. This might not apply to persons who expect to acquire a living by teaching the classical courses in the schools, but these persons are exceptions.

The masses of men must always do the practical work of life, and in order to do it well, they should be trained as early as possible to know how to do those things that they must in future years do in order to live.

Carroll D. Wright, in his outline of "Practical Sociology," says:

"That part of the public school system which interests the greatest number of persons is to be found below the grade known as the high school, for probably 90 per cent of the children passing through our public schools leave them at the grammar grades, or the highest grade under the high school. Public interest is therefore largely centered in the perfection of the primary, intermediate, and grammar grades, in which many a child is taught all that he will ever receive in the way of education before entering upon his life work."

GRANVILLE LOWTHER

Methods in Agricultural Education

Nearly every one today believes that our schools must become more closely allied to the industries by which our people live. But our power and prosperity in the future depend upon the skill and the intelligence by which our people are able to practice the arts of agriculture and horticulture.

It is easy to agree that the schools shall take in agriculture. But it is tremendously difficult to find out just how this may be done. No one knows as yet. There must be myriad experiments and a thousand grotesque failures before we succeed. The casual observer does not dream of the difficulties and stumbling blocks in the way. It is the work of years to get a new idea really planted and growing in the set conservatism of a social institution like our school system. There is danger, when professional educators take hold of a live and vital thing like agriculture, that they take all the real live interest out of it in order to teach it in a conventional way. When it becomes embalmed in regular text books, perfunctory recitations, and periodical examinations, it fails of its true mission. If it would truly succeed, ways must be found to keep it alive, to keep it in touch with country life, to invest it with the realities of extracting a living from the soil.

Teachers of agriculture are not yet bred. Hundreds of years have been spent in growing good teachers of mathematics, literature, language—let us not be run away with by the notion that we can build up an agricultural Rome in a day. It is necessary to have some foundation for any kind of building. It is highly desirable to instil a spirit of sympathy for agriculture into the minds of all the people and to bring them into actual contact with the agricultural life. For many generations everything in education has tended away from the farm. The district school never does one thing in all its curriculum to prepare the boys and girls for a living on their fathers' farms. It heads them rather toward clerkly or professional pursuits in the town or city.

The object of this article is to call attention to the fact that we must find something different from the traditional text book method of approach if we would really get the genius of agriculture into the public schools; to name two or three methods of approach that are different, and to suggest that the best plan for a school to undertake agriculture is by finding ways to co-operate personally with the nearest agricultural industry, by actually entering into its spirit and its labors.

A movement has started in the prune orchards of the Santa Clara valley, California, that bears directly upon these educational questions. The idea is to enlist the interest and the labor of the children and the people of the villages and towns in the harvesting of perishable fruit crops, paying them full market wages for their work, furnishing them safe and attractive camping places, facilitating their coming and going, and giving them a season of healthful, active outdoor life. This is a practical course of study in California agriculture that may well command the co-operation of the educational forces of the state.

The school term may very well begin and close so that the children and their parents can take part in the chief industry of the neighborhood.

The raising of a school garden is a most delightful and practical method of approach. Not all teachers have the knowledge and sympathy that make for the highest success, but nearly all come of ancestry that lived by the soil; and if their minds are open, their hearts willing, the old interest will come back. Not all rural schools are adapted to gardening, but many of the most successful school gardens are raised at the homes of the children.

Most of the things we now teach would group themselves about and grow out of this practical life—arithmetic, bookkeeping, nature study and science. And let us remember that the thing does not even need to be a commercial success in order to be successful educationally. * * * Failure is as natural as success—probably more so. If the bugs get away with the crop, if neglect of a certain point cuts out the profit, if the season was unfavorable, if the frost came too late, was the enterprise then destitute of value, and a fair mark for clumsy and thoughtless wit? By no means. It is real life, and it is doing the work it set out to do, no matter whether the actual returns were large or small.

It is the experience of many states that the most efficient approach to agriculture is by the organization of boys' and girls' agricultural clubs. These are formed for some specific and tangible purpose, as a competition under certain rules in the growing of wheat, or potatoes, or cotton, the raising of poultry or gardens, the baking of bread, the canning of fruit. New York is the pioneer.

Under the direction of Cornell University this state began work in 1898. It now has a membership of 75,000 boys and girls in its clubs, and has for its official organ the Cornell Rural School Leaflet, that goes to 7,000 teachers. Nebraska began this work in 1905, devoting its chief energy to the growing and the cooking of corn, under directions and recipes sent from the State University. In the counties, and finally for the state, with a "corn banquet," bringing together 2,000 to 3,000 boys and girls from all over the commonwealth. The county superintendents of Winnebago county, Illinois, and Keokuk county, Iowa, have made national reputations in this work.

An agricultural club may be organized in a single school, and may do enthusiastic work. It is larger and better for the whole county to undertake it. Ambitious county superintendents of schools in the rural regions have an inspiring opportunity for usefulness in this field. There should be means provided for public displays of the results of competition. There should be some periodical to knit the organization together. There should be some leader who can travel about among the different clubs encouraging them and telling them what their fellows are doing. Doubtless the time will come when the superintendents and teachers of agricultural counties will be chosen for enthusiasm and skill in this very kind of work. There is a fascinating field lying ready, a field for fame as well as for the highest service to the state.

EDWARD HYATT,
California State Superintendent of Schools.

Egg Plant

The egg plant is a native of the warm countries, but has become adapted to almost all parts of the United States. Professor Beattie describes its cultivation as follows:

The plants for this crop should be started and handled in the same manner as for the tomato. After the weather has become settled and the ground quite warm, set the plants in the garden in rows 3 feet apart and 2 feet apart in the row. The soil best adapted to the production of egg plant is a fine, rich sandy loam and should be well drained. Cultivate freely and keep the plants growing rapidly. Many growers believe that fresh stable manure should not be used in connection with the growing of egg plant and that the land should not contain unfermented vegetable matter to any extent.

Egg Plant.
—*Masted Photo.*

Egg plant is used in several ways, among which are the following: Peel and cut into slices one-half inch thick, soak in salt water one hour; boil until tender; then coat with rolled crackers or flour and fry in butter or fat. Another method is to steam or bake the egg plant whole and serve in the shell, the pulp being eaten with salt, pepper and butter.

Varieties

Black Beauty, Early Long Purple, Early Dwarf Purple.

EGG PLANT DISEASES

Anthracnose

Gloeosporium melongenae, Ell & Hals.

The anthracnose fungus of egg plant attacks the fruits of egg plant and causes spots in them. These show early as pits in the surfaces of the fruit which show the usual border.

Bacterial Blight

Bacterium solanacearum Erw. Sm.

The common solanaceous blight organism attacks the egg plant as well as the potato and tomato. Where attacks occur destruction of the affected plants is all that can be done.

Fruit Rot

A fruit rot of egg plant likewise occurs and may at times appear as a leaf spot fungus. This, like the anthracnose and leaf spot, should yield to treatment by sprays. Ammoniacal copper carbonate may be used toward the ripening period.

Leaf Spots

Two or more leaf spot fungi have been recorded on egg plant.

Rot

Botrytis

A mouldy decay of fruit giving a dusty appearance. Not serious.

Stem Rot

Nectria ipomoeae Hals.

The stem rot fungus of sweet potato has been described upon egg plant by Dr. Halsted. The conidial stage is evidently a species of fusarium and it may or may not be a different one from that with which we have to contend upon the potato; it is recorded by Dr. Halsted as the same that occurs on sweet potato.

References

Smith. Delaware Experiment Station Bulletin 70.

A. D. Selby. Ohio Experiment Station Bulletin 214.

Duggar. Fungus Diseases of Plants.

Smith. California Experiment Station Bulletin 218.

EGG PLANT PESTS

GREENHOUSE WHITE FLY. See *Cucumber Pests.*

HARLEQUIN CABBAGE BUG. See *Cabbage Pests.*

RED SPIDER. See *Apple Pests.*

EGYPTIAN BEET FOR ALASKA. See *Alaska.*

EGYPT, IRRIGATION IN. See *Irrigation.*

Elderberry

The elderberry is the purple, black, drupaceous fruit of the common elder, having a sweet, acidulous taste. The shrub belongs to the *genus Sambucus* of the natural order *Caprifoliaceae.* There are about 20 species characterized by opposite pinnate leaves, small white flowers, usually in compound cymes, and black, red, white or green juicy fruits. They are not grown largely for home use or for the market. They succeed well on nearly all varieties of soil, but are found more frequently along the streams, in rich, sandy loam, and grow successfully in nearly all the states. They are easily propagated by means of root or stem cuttings, and are often grown for ornamental purposes, since they grow rapidly, are rather graceful in appearance, and grow to a height of from 8 to 12 feet.

The fruits are used for making pies, jellies, and elderberry wine. The wine has rather a pleasant taste, and is said to have some medicinal properties, especially for asthmatics.

[*] In considering the possibilities of the elderberry it is well to first mention its good points.

1. Late blooming, being absolutely beyond danger of late spring frosts.
2. Sure cropping. I think that there has not been a failure of the wild elderberry crop for 30 years.
3. Freedom from disease. So far I have not noticed any disease on the elberberry.
4. Freedom from insects. So far as I know there is only one insect troublesome to the elderberry.
5. Ease of gathering the fruit. The berries grow in large bunches, easily picked and there are no disagreeable thorns to interfere with the operation.
6. Time of ripening. The elderberry ripens just after the blackberries are gone and fills in a period otherwise without berries.

There are some bad features about the plant, chief to be mentioned being the difficulty of eradicating it when once it becomes established. But this might prove a desirable feature once a market was created for the fruit, as a plantation would be well nigh permanent and would require the minimum of attention.

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[*] F. C. Pellett. Iowa State Horticultural Society, 1909.

By itself the elderberry sauce is a little insipid but with a few drops of apple vinegar added it is unsurpassed for pies and mixed with rhubarb makes splendid sauce. A mixture of apples and elderberries makes a good jelly.

As an ornamental shrub also the elderberry is worthy of a place.

If we can succeed in making as great improvement in this fruit as has been made in the native wild grape in producing the Concord, we will have a fruit equal to anything now on the list, but of course it will require a long period of painstaking experiment. On our grounds the clump that gets the wash water near the kitchen door produces much larger bunches and larger berries than those carefully cultivated in the garden.

GRANVILLE LOWTHER

ELEMENTS REMOVED BY VARIOUS CROPS. See *Apple Orchard Cover Crops.*

Endive

A salad crop, grown for its blanched leaves about the same as head lettuce. In the Southern states, it does better as a fall than as a spring crop.

"Sow the seeds thinly in drills, and when the plants are well established thin to 8 inches. Water and cultivate thoroughly in order that a good growth of leaves may be made. When the leaves are 6 to 8 inches in length draw them together and tie them so the heart will blanch. The leaves should not be tied up while wet or decay will follow. The heads should be used as soon as blanched. For winter use sow the seeds rather late and remove the plants, with a ball of earth adhering to the roots, to a cellar or cold frame, and blanch during the winter as required for use.

"Endive is used as a salad at times of the year when lettuce and similar crops are out of season."

ENGLISH WALNUT. See *Walnut.*

EUROPE AS FRUIT MARKET. See *Market.*

EUROPEAN GRAIN APHIS ON APPLE. See *Aphids.*

Evaporation of Apples

The utilization of the poorer grades of fruit is frequently an important matter to the grower. That portion of a crop which is of too low grade to market in the ordinary way can often be made to pay a large part, at least, of the expense of maintaining the orchard if it is converted into some other form than that practiced with the better grades. In some of the apple growing districts the evaporating industry has kept pace with the planting of orchards and has become an important factor in the utilization of the fruit which is unfit or would prove unprofitable for marketing in the fresh state. In some of the older apple growing sections, such as Western New York, the number of evaporators in use is very large, and for many years the industry has been well established. Its present state of development, however, has been a matter of gradual evolution. During its course methods have changed more or less, appliances have been perfected, and marked improvement in the construction of the evaporators themselves has been accomplished.

Many evaporators are located in villages, at railroad stations, and at other central points; a considerable number, however, are erected in close proximity to or in conjunction with apple orchards, owned and operated by the fruit growers themselves, each plant being intended only for "working up" the fruit not otherwise marketed from a single orchard. The evaporators located in towns or villages are usually operated by men who make a business of evaporating fruit, and the apples handled in them are bought wherever they can be obtained to best advantage. These are generally of much larger capacity than the ones at the orchards, and the type of construction and the character and number of conveniences correspond.

The average weight of ripe winter apples of mixed varieties is about 50 pounds to the bushel. In evaporating them about

40 pounds of water per bushel, or approximately 5 gallons, passes off in the form of vapor. The evaporating of apples may be said, in brief, to consist of driving off as rapidly as possible, by means of artificial heat, enough of their moisture to prevent deterioration through decay or other natural processes which occur in fresh fruit and at the same time to maintain a desirable texture and flavor.

Buildings formerly used for other purposes are frequently converted into evaporators. An old dwelling house, a blacksmith shop, a cheese factory, and even a school house and a church are examples. Others are built substantially of brick or stone, thus reducing the risk from fire, which is an important consideration.

A large quantity of fruit, in the aggregate, is still dried by primitive methods. In rural communities, especially where the "home orchard" represents the extent of fruit growing, one often sees during the autumn a flat-topped rock, the roof of some low, easily accessible shed, or other flat surface on which have been spread apples, sliced or quartered, for drying in the sun. In some sections "strings" of quartered apples hanging by a doorway to dry, or behind a kitchen stove, are still familiar sights.

While much of this sun-dried fruit is intended for home use, large quantities of it are marketed, and it is also exported to some extent. This fruit is commonly referred to as "dried apples," in distinction from that handled in evaporators, which is known as "evaporated apples."

Types of Evaporators

Many types of evaporators are now in use, though in a general classification they may be grouped, for convenience, under a few heads. The more important of these are:

1. Cook stove evaporators.
2. Portable outdoor evaporators.
3. Kiln evaporators.
4. Tower evaporators.
5. Miscellaneous types.

It is well to emphasize, at this point, the fact that the descriptions which follow are representative of types only and that the details of construction and arrangement admit of endless modification. For the most satisfactory results, however, in all types, thorough ventilation is essential to insure a good circulation of heated currents of air.

Cook-Stove Evaporators

Some of the cook-stove evaporators are small box-like structures, usually made of sheet iron or galvanized iron, of such a size that they can be placed on top of an ordinary cook stove. They are arranged for holding a series of small trays, on which the fruit is placed after it has been prepared for drying. Various sizes are in use, from one covering only a portion of the top of a common kitchen stove and having a capacity of only a bushel or so a day, to those requiring the entire top of a stove on which to operate it.

Another style consists of a watertight rectangular box of tin, upon the upper surface of which the fruit is spread. The heat is supplied by boiling water, with which the evaporator is filled, the temperature being maintained by placing one end of the evaporator on top of a stove. There are various other styles of this type.

Portable Outdoor Evaporators

Portable evaporators are especially convenient when it is desired to dry only a few bushels of fruit at any one time. The usual sizes have a capacity of 5 to 10 bushels a day, and even more in some cases, although the quantity will of course vary with the attention given to them. As they are complete in themselves and are not too heavy to be readily moved, they may be placed where-ever convenience from time to time dictates.

There are other styles of this type obtainable from manufacturers which are made of sheet iron, usually galvanized. As no wood enters into their construction, danger from fire is eliminated. One of these styles is provided with a heat deflector and so constructed that hot currents of air pass over the fruit as well as up through it, the claim being made that this movement of air induces a more rapid drying of the fruit than in ordinary methods of construction.

Kiln Evaporators

Of the types having sufficient capacity for handling apples from large commercial orchards, the kiln evaporator is by far the most important.

While the principles of construction of the different evaporators of this type are similar in all cases, the details and the arrangement of the appliances are endlessly varied.

In constructing kilns the same general principles are followed, whether the evaporator is a small one with only a single kiln or an extensive establishment having several of them. The most satisfactory size of kiln, all things considered, is about 20 feet square. This is a convenient size to fill, so far as the preparation of the fruit is concerned; the heat can be well regulated, made sufficiently intense for the purpose desired, and evenly distributed, so that the fruit will dry uniformly, and for various minor reasons a kiln of this size is a desirable "unit" in the construction of evaporators of this type.

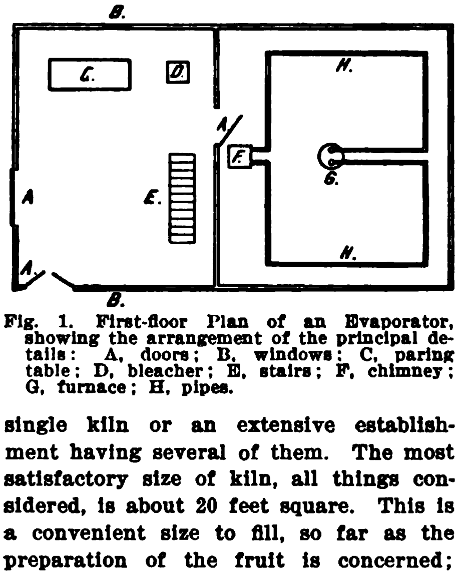

Fig. 1. First-floor Plan of an Evaporator, showing the arrangement of the principal details: A, doors; B, windows; C, paring table; D, bleacher; E, stairs; F, chimney; G, furnace; H, pipes.

A kiln consists essentially of a floor made of slats and placed over a furnace room or over a system of steam pipes. The floor is usually built from 10 to 12 feet above the floor of the furnace room. Provision should be made for regulating the heat by means of small openings at the base of the walls, communicating with the outside, which can be opened or closed as desired. The inflow of cold air can thus be regulated. Such control is especially desirable in windy weather. While many evaporators are constructed without special provision of this kind, it is an important point to have such openings, particularly if the walls are brick or otherwise made very tight, so that there is but little circulation of air.

If the evaporator is a frame building, the walls of the furnace room may well be plastered or covered with asbestos paper to lessen the danger of fire, which may otherwise be great, because of the intense heat generated within them.

If the walls, at least the portion below the kiln floor, are double, with an air space between the two sides, the insulation will be more perfect than if they are solid or of only a single thickness, thus best conserving the heat and increasing the efficiency of the plant. The height of the walls of the kiln above the drying floor should be sufficient to permit an attendant to work on the floor conveniently and with comfort.

Some means for the escape of the air laden with moisture from the fruit is necessary. This may be provided for by means of an opening in the roof, or a cupola-like ventilator may be built, the sides of which should consist of slats placed so that they overlap one another as in an ordinary window blind. Another form of ventilator is in the form of a tower about 3 feet square and extending 8 or 10 feet above the roof, which is sufficiently high to cause more or less draft, and hence augments the circulation of hot air through the fruit.

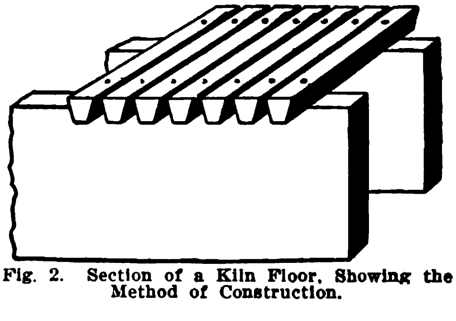

Fig. 2. Section of a Kiln Floor, Showing the Method of Construction.

The kiln floor is constructed of strips especially designed for the purpose. Such floors are generally made of poplar or basswood strips, seven-eighths of an inch thick, one inch wide on the top surface and one-half inch wide on the under side. In laying the floor, these strips are placed one-eighth to one-fourth inch apart on the upper surface. This makes the space between them wider on the under side than on the upper, thus allowing the small particles of fruit which work down between them to drop through without clogging the intervening spaces. Reference to Fig. 2 will make plain the method of constructing the floor.

The heating apparatus, parers, slicers, bleachers, details of arrangements, etc., referred to here are described under their respective headings.

Tower Evaporators

At one time tower evaporators were extensively used in some sections for apples, but in recent years this type has been largely superseded by the kiln evaporator, so that at the present time there are comparatively few towers in use.

As the name of this type implies, a tower is its characteristic feature of construction. It may be likened to an immense chimney, provided with the necessary appliances for receiving the fruit, except that the heat alone is allowed to pass through it, a separate flue being provided for the smoke.

There is no more definitely prescribed manner in which these towers are constructed and arranged than there is governing the construction of kiln evaporators. They may consist of one tower or several. If several, they may be entirely disconnected from one another. They may be built side by side or back to back, opening on the opposite sides. They may be entirely within the building, extending through the several floors from basement to roof and projecting above, or entirely on the exterior, opening into the interior after the manner of an "outside chimney," common in some sections of the country. They may be built either of wood or brick. They are usually from 4 to 5 feet square, inside measure, and 30 or 35 feet in height, as desired. Heat is supplied by a furnace at the bottom of the tower.

There are two principal methods of constructing the towers in regard to receiving and handling the fruit to be dried. The apparatus in one case consists of two endless sprocket chains operating over wheels properly adjusted at the top and bottom of the tower. Each sprocket chain is provided with swinging brackets, corresponding with one another on each chain, for holding the racks on which the fruit is placed for drying. In one specific make of apparatus these brackets are arranged in series of six each, so that this number of racks can be put in, one immediately above another. A space of two feet or so intervenes on the sprocket chains between each series of six brackets. This sprocket-wheel-and-chain device for carrying the fruit in the tower is turned by means of a crank, which works on the outside of the tower.

The racks on which the fruit is dried consist of frames 4 feet long and 21½ inches wide, over which is placed galvanized wire netting having a ¼ inch mesh. This size of rack permits the apparatus on which the racks are carried in the tower to work readily, those on one side passing upward, while those on the other side move downward, without interfering with one another.

In this method the point of admitting the fruit to the tower is near the base on the first floor. When the fruit is dry it is removed at the same point.

In operating the tower, the apparatus is turned every few minutes to bring each rack of fruit in its course to the base of the tower, where the heat is greatest. In this way it is made to dry uniformly, and each rack is brought repeatedly into view of the one in charge; hence he is always able to know its exact condition.

In one particular evaporator of this kind there are three towers, about 30 feet high, each holding 120 racks. The capacity of a single tower is about 100 bushels a day. The fruit is prepared in every detail the same as for drying in kilns.

In the other method the racks are about 4 feet square and occupy the entire cross section of the tower instead of half the space, as in the method just described. The racks are admitted to the tower at the same point as in the other style, but as each rack is put in position it is raised by a lever attachment, together with the other racks which may have been already put in place, and held in the new position by dogs or clutches which work automatically, allowing the racks to be moved upward, but not permitting them to move downward. The distance which the racks are raised each time the lever is moved is sufficient to allow another rack to be inserted below them at the usual point of admission. It will thus be seen that the racks are gradually raised from the point of insertion on the first floor to the point on the second floor where they are removed. The racks do not come into the view of the operator from the time they are inserted until they reach the place where they are removed, and so do not come under the same scrutiny of the operator as in the other style. The arrangement of the furnaces is the same in both methods of construction.

Miscellaneous Types of Evaporators

While the types of evaporators previously described admit of endless modification in the details of construction, and other types and styles of lesser importance are frequently seen, there is but one additional evaporator to which it seems desirable to refer in this connection. The type in question has no particular designating term applied to it. Several styles which possess some features similar to this one have been called "cabinet evaporators," and this term is applicable in the present instance. While it appears to be largely of local reputation, it is believed to possess certain points of merit worthy of more extended application in constructing evaporators of considerable capacity. The fruit is dried on racks similar to those used in tower evaporators.

In the first one of this type to be erected, so far as the writer has been able to learn, and which is still in use, the compartments in which the fruit is dried are located in the central part of a large room in which the fruit is sliced and handled after it is removed from the evaporator. Each compartment, of which there are three, is slightly more than eight feet square, or large enough in cross section to receive four racks (two square) on the same plane. The two opposite faces or sides of these compartments are a series of narrow doors, about six inches wide and slightly more than four feet long, which extend horizontally. These doors are hinged on the lower side and held in place by a button at the top. The sides of the interior are supplied with cleats on which the racks rest. Two racks placed one directly on the other are admitted at each door. In the particular case in question, there is sufficient space between the floor and ceiling of the room for eleven of these doors, each door admitting, as stated, two racks. It will thus be seen that the capacity of each compartment is 88 racks.

As arranged in this evaporator, the racks are admitted to the drying compartments on the same side of the room that the apples are sliced, the ones that are put in first being pushed to the opposite side of the compartment, thus making room for the second set of racks in the course. The attendant in charge of the drying makes his examinations and removes the fruit when dry through the doors on the opposite side of the compartment.

It will thus be seen that the method of handling the fruit is similar to that employed in the case of the tower driers, but the work is all done on a single floor of the evaporator.

The heat is supplied by a system of steam pipes which extend in horizontal tiers through the compartments between the racks.

Evaporator Appliances, Etc.

During the development of the industry, the machinery and other appliances used in the process of evaporating apples have undergone great changes, until at the present time a high degree of perfection has been attained. Reference to some of the more important articles for equipping an evaporator may be of value to those who are unfamiliar with them. Nearly all of them may be obtained from manufacturers ready for use, hence detailed descriptions are unnecessary in most cases.

Paring Tables

There are two general plans of construction. One consists of a single long table common to all the machines; the other, individual tables, one for each parer.

Where several hand parers are used they are commonly placed on opposite sides of a relatively wide table, through the center of which, between the two rows of parers, is a sluice 10 or 12 inches wide and as many inches deep. An endless belt the width of the sluice covers its bottom. This belt works on rollers and is operated by means of a crank at the outer end. As the apples are trimmed they are thrown into this sluice, and the helper who attends to the bleacher fills the crates or trays in which the fruit is handled by turning the crank which moves the belt forward, carrying with it the fruit which has been placed thereon. By this means all the trimmers contribute to the filling of a single tray, thus making it possible to get all the fruit into the bleacher in the shortest possible time after it is pared. This is considered essential in order to make the highest grade product. Such a table as this is especially adapted to small evaporators which are run entirely by hand power.

In power evaporators a long table common to all the parers is generally used. The necessary carriers for removing the apples and the parings operate beneath the table. If individual tables are used in such cases, a small sluice may connect each table with a carrier which works just beneath the floor, which carrier in turn delivers to an elevator that connects with the bleacher. By thus placing below the floor the carrier which takes the fruit from the tables, the space above is left unobstructed, which would not be the case were the individual tables connected with a common carrier.

Paring Machines

Paring machines are made for operating either by hand or power. The more recent patterns have two, or even three forks for holding the apples while they are being pared. The attendant puts an apple on one of the forks while one on another fork is being peeled.

The number of bushels which can be pared in a given time of course varies with the size and condition of the fruit, but 70 or 75 bushels for a day of ten hours (or even more if the fruit is of good size and the machine is speeded up to its limit) is not an unusual amount for a good power machine.

The hand machines are equally complete and satisfactory in their working. Under favorable conditions an experienced operator will pare 60 or more bushels a day if the fruit is not too small.

Bleachers

In order to make the fruit as white as possible, it is usually subjected to the fumes of burning sulphur. The apparatus in which the fumes are applied is called a bleacher.

The form and manner of construction vary greatly, as do most of the other appliances. The requisites are a perfectly tight compartment having a capacity commensurate with the size of the evaporator and the necessary facilities for burning the sulphur.

Perhaps the simplest form of construction consists of a box sufficiently long to meet the requirements, placed horizontally, and large enough in cross section to admit the boxes or crates in which the fruit is handled. Rollers are placed in the bottom, on which the crates rest, which permit them to be moved along with but little friction. The crates are entered at one end of the bleacher, those previously put in being pushed along to make room for the following ones. The sulphur is usually burned immediately below the point where the fruit is put into the bleacher. A short piece of stovepipe is placed at the opposite end for the escape of the fumes after they have passed through the bleacher.

Another simple bleacher in which the fruit is handled in bulk (not in crates) consists essentially of a large square box, the interior of which is fitted with a series of inclined planes sloping in opposite directions to prevent the fruit from dropping to the bottom in a compact mass. The fruit is usually admitted at the top directly from the paring table. It then rolls from one inclined plane to another to the bottom, where there is the necessary opening, with means for closing it tightly to prevent the escape of the sulphur fumes, for removing the fruit when it is bleached. The sulphur is burned beneath the lowest inclined plane.

In the case of the bleacher where trays are used the sides of the interior are provided with series of cleats for supporting the trays in which the fruit is handled. The distance between the cleats is slightly more than the depth of the trays. The sides toward the platform consist of series of closely fitting doors about six inches wide, placed horizontally, through which the trays are entered and removed from the bleachers. The trays of fruit are put into the bleachers and left in the sulphur fumes a sufficiently long time for the fruit to bleach. The sulphur is burned at the bottom of the bleachers, and the tall shafts which are to be seen projecting from the top are ventilators, which give sufficient draft to take the fumes up through the fruit and to allow their escape at a point some distance above the workmen.

While all of these types may do the work well, they are so constructed that much handling and lifting of the fruit is necessary.

There is an upright style in common use in some sections, which reduces the lifting of the fruit by hand to a minimum and serves not only as a bleacher, but also as an elevator. This is especially suited to the smaller, two-story evaporators, operated without mechanical power, in which the slicing is done on the second floor and having the kiln floor on the same level. By this means the fruit is raised from the first or paring room floor to the level of the kiln floor while it is being bleached.

The construction is comparatively simple. It consists of an upright box extending from the first floor to three or four feet or any convenient height above the second. The cross dimensions are such as to admit the crates or trays in which the fruit is handled. The crates are admitted to the bleacher at a convenient height, 18 inches or two feet from the bottom, through a trapdoor or some other arrangement which can be tightly closed to prevent the escape of the sulphur fumes.

A movable frame, slightly smaller than the cross dimensions of the bleacher, rests on a solid support just below the point where the crates are entered and on which the crates are placed when pushed inside. This frame is connected with a level at the top of the bleachers by means of iron rods which are attached to a cross arm on the level and extend down the sides of the bleacher to the frame. The relative length of the long and short arms of the level must be such that in the sweep of the long arm the frame on which the crates rest will be raised a distance slightly greater than the depth of the crates in which the fruit is handled. There are dogs, or catches, on the inside of the bleacher, which work automatically and permit the crates to be moved upward, but not downward. When a crate is put in place, the lever is pulled down, usually by means of a rope which passes through the second floor within convenient reach of the helper who handles the crates. The crate which was last put into the bleacher and all that may have been put in previously are raised to the point where they are caught by the clutches just mentioned and so held in that position. On releasing the lever, it regains its former position and the frame drops to its place just below the level of the doorway through which the crates are admitted and is then ready for receiving another crate. A small-sized stovepipe or other tubing should extend from the top of the bleacher to the exterior of the building to permit the escape of the sulphur fumes after they have passed through the fruit.

The crates are removed through a tightly closing door in the bleacher on the second floor, where the apples are sliced and spread on the kiln floor.

The sulphur is burned at the bottom of the bleacher, below the point where the fruit is admitted. It is a safe provision to have this portion of the bleacher coated with cement or lined with asbestos, especially the floor, to lessen the danger of fire.

Perhaps the most satisfactory bleacher for evaporators in which an engine is installed is the "power" or "horizontal" type. Its characteristic feature is the movable bottom, or rather false bottom, on which the fruit is carried through the bleacher.

Briefly stated, this bleacher consists of a tight box about three feet square and 20 or more feet long, the length being regulated by the capacity of the evaporator in connection with which it is operated and the time it is desired to bleach the fruit.

The apples are conveyed from the paring room to the bleacher by a carrier, or elevator, similar to those already referred to, and are dropped into one end of the bleacher, falling on the movable bottom, which consists of an endless belt of "lugs," turned by the proper gear attachment. The speed of movement is governed by the gearing, and is adjusted to correspond with the time it is desired to keep the fruit in the bleacher and the length of the latter. When the fruit has been carried through the bleacher, it passes to the slicer, which is located in close proximity to the bleacher. The end of the bleacher is closed when in actual operation by means of a closely fitted piece of canvas or other effective arrangement. Provision for the escape of the fumes may be supplied as suggested in connection with the upright type previously described.

Sulphur Stoves

In a large proportion of instances nothing more elaborate than a broken or otherwise discarded iron kettle or some similar receptacle is used for containing the burning sulphur. This is the case if the compartment in which the sulphur is burned is a portion of, or in direct communication with the bleacher. In other instances, such as the power bleacher just described, where in some cases it is more convenient to burn sulphur at some distance from the bleacher, a small sheet-iron stove about a foot square and 12 or 15 inches high is used. This is connected with the bleacher by means of a small stovepipe.

Slicing Machines

There are several styles of slicers now obtainable which are operated by hand, foot, or mechanical power. In general, they consist of a table in which a series of knives is so arranged that when the apples are carried over them by a revolving arm they are cut into slices. In at least one type the apples are delivered to the slicing table by an attachment which works automatically.

The capacity of slicers varies somewhat, as does the industry of the men who operate them, but from 200 to 400 bushels for a day of ten hours may be expected of a good machine.

Small hand slicers which slice only a single apple at a time are sometimes used in the smaller evaporators.

Quartering machines are used instead of slicers, if it is desired to dry the fruit in quarters instead of slices.

Crates and Trays

Crates and trays are essential accessories. A relatively large supply facilitates the handling of the fruit both before and after it is pared, especially where there are no elevators or carriers to convey the fruit from one point in the evaporator to another. They are usually made to hold about a bushel. The bottoms of those in which apples are bleached should be made of narrow slats, and preferably also the sides, to permit a free circulation of the sulphur fumes through the fruit.

Racks

In the construction of all racks on which fruit is dried, whether for use in a large tower evaporator or in a small cook stove type, a special caution should be observed to select only the best grades of galvanized wire netting for making the racks. If poorer grades are used the acids of the fruit are likely to act on the metals, producing undesirable results.

Heating Apparatus

Satisfactory results are so dependent upon the heating apparatus that this becomes one of the most important features of an evaporator.

In the smaller types of evaporators, where comparatively little is involved and the question of fuel does not enter seriously into consideration, almost any small stove commensurate with the size of the particular evaporator in question may be used.

In the larger kiln evaporators the matter is a more important one. Formerly, ordinary cast-iron stoves were used considerably, two or more of them frequently being required to heat a single kiln, but these have largely gone out of use. In their stead large furnaces are now most commonly used. These are specially designed for the purpose and are provided with relatively large fire pots, correspondingly large ash pits, and large radiating surfaces. As it is necessary to burn a relatively large quantity of fuel in a given time, the size of the grate is made with this end in view. For a kiln floor 20 feet square, or 400 square feet of surface, the grate surface is usually about three feet in diameter, containing from five to seven square feet.

As to the most satisfactory length of pipe connecting the furnace and chimney, opinions differ. Perhaps the most common method of piping is the following: The furnace, with two flanges for attaching the pipe, is placed in the center; the pipe from each flange is then extended to the side of the room opposite the chimney, and from this point the two sections, extending in opposite directions, follow the wall, at a distance of two or three feet from it, to the chimney. In a kiln 20 feet square, some 65 or 70 feet are thus required. Ten-inch pipe is a common size to use for this purpose. It is placed about three feet below the kiln floor.

Some operators think that a better distribution of heat is obtained if the pipes extend back and forth, two or three feet apart, under the entire floor of the kiln, thus requiring 200 feet or more instead of the shorter length above suggested. The greater length, however, is less frequently used than the smaller.

In some cases the heat is so intense directly over the furnace that the fruit dries more rapidly in the center of the floor than about the sides. To regulate this and make the drying as uniform as possible, a "deflector," consisting of a piece of sheet iron or tin several feet square, is attached to the floor directly above the furnace.

Open grates, which in effect are furnaces with all parts above the grates removed, are used occasionally and are recommended by some because they require less fuel, less attention to firing, and will dry the fruit in a shorter space of time. On the other hand, so much dust rises from them that they are not used in making the best grades of fruit.

Tower evaporators may be heated by the same style of furnaces that are used in kiln driers. The size of furnace sufficient to evaporate a given quantity of fruit in a given time is probably about the same in either type of evaporator.

In some respects a steam system is the most satisfactory method of heating, but it is comparatively little used, possibly due to the larger first cost of installing such a system. It is especially applicable in case of evaporators that are operated in connection with some other business that requires the use of considerable steam power, such as a large cider mill, which requires the power for running the presses.

In kiln evaporators the steam pipes are generally placed in as close proximity to the floor of the drying room as is convenient—within a foot or even closer. That every steam pipe nearest the floor may supply the greatest amount of heat it should have its own return to the main return of the system.

One inch pipe is generally used for such systems. No very definite data are available in regard to the amount necessary to supply the requisite heat. Several kilns, however, which are said to work admirably, have about 650 running feet of pipe for every 100 square feet of floor space. One-half of this is "riser," the other half "return."

In the type of evaporator referred to as "cabinet evaporators," the length of one inch steam pipe required per square foot of surface directly exposed to the pipes is considerably less than in the case of the kiln just described, although it is probable that in the system in question a greater degree of heat can be maintained than with the usual piping for a kiln. As previously mentioned, in this system the pipes are arranged in horizontal tiers, the racks on which the fruit is placed being inserted between them. Hence, the upper racks receive more or less heat from the lower tiers, as well as from those to which they are directly exposed. In one evaporator of this type, which gives excellent satisfaction, and in which the drying compartments are about nine feet square—that is, large enough to hold four four-foot racks (two square) in the same plane—there are thirty-two one-inch pipes in each tier. Each pipe is about 8½ feet in length, or approximately 270 feet in each tier. In the evaporator referred to there are eight tiers in each compartment. Eight racks—two deep—are placed between each tier of pipes.

In another evaporator of this type, having a capacity of 400 bushels every twenty-four hours, a 40-horsepower boiler, with about 15 square feet of grate surface, furnishes the necessary steam when run at a pressure of 40 to 50 pounds. This is sufficient for drying the fruit and for running the parers, slicers, elevators, etc., required to handle this quantity of fruit. The steam pressure at which such systems are run varies considerably according to the individual requirements of the systems. A range of from 40 to 90 pounds has been noted in different evaporators.

Fuel

Where the owner of an evaporator has an abundant supply of wood and it can be cut at times of leisure, this is probably the least expensive fuel in actual cash outlay that can be had in most of the apple-growing sections. In fact, under these conditions, it is commonly estimated that the fuel costs nothing. But in a great number of cases fuel has to be bought, even by operators who are drying apples from their own orchards.

For kiln evaporators using the common type of furnaces, hard coal is probably the most satisfactory fuel, and requires less attention than any other. Coke is sometimes used, and if it were as satisfactory as coal, other things being equal, it would be the cheaper fuel. But it requires much attention, and even with the best of care it is difficult to maintain a uniform degree of heat. A combination of coal and coke is sometimes used with satisfactory results, in which case the faults and advantages of one tend, in a measure, to equalize those of the other.

In a steam-heated plant soft coal serves the purpose in a satisfactory way, and in most apple-growing sections is probably cheaper than any other fuel that is readily available.

Quantity of Fuel Required

While the amount of fuel necessary to dry a given quantity of fruit will vary more or less, depending upon the conditions of the weather, the efficiency of the furnace, the construction of the kiln, the percentage of moisture to be left in the fruit, and various other things, it is roughly estimated that a ton of hard coal, for a kiln evaporator, will make a ton of dried fruit. Probably the average requirement is rather more than this. It is claimed that a tower evaporator requires slightly less for the same results. Open grates also considerably reduce the amount of fuel necessary for a given quantity of fruit, but on account of their objectionable features they can not be used for the better grades of apples. Coke is rather more efficient, 2,600 to 2,700 pounds of apples being evaporated, it is claimed, by a ton of fuel.

A good steam system should require considerably less than a ton of soft coal to a ton of dried fruit, one estimate being about one-half this amount.

These estimates are for evaporating sliced fruit. If the apples are quartered or dried whole, being merely pared and cored, considerably more fuel is required. From 25 to 50 per cent more fuel should probably be estimated for in such cases.

Apples Suitable for Evaporation

There is an increasing demand for dried apples of the highest quality. The tendency has sometimes been to make quantity at the expense of quality. But prices are governed not only by the supply but also by the grade. The cleanest, whitest fruit, that is well cored, trimmed, bleached, ringed, and dried, is most in demand. Carelessness in any particular injures the product.

Primarily the economic usefulness of an apple evaporator is through its utilization of windfalls and the poorer grades of fruit which can not be marketed to good advantage in a fresh state, and it is these grades that are most often evaporated. But the magnitude of the crop also influences the grade of the evaporated product in a decided way. In seasons of abundant crops and low prices for fresh fruit large quantities of apples that would ordinarily be barreled are evaporated and the grade of stock produced is correspondingly improved. On the other hand, in years of scanty crops, when all apples that can possibly be shipped are in demand at high prices, only the very poorest fruit is evaporated, as a rule, thus lowering the grade of the output.

The commercial grading of evaporated apples is based primarily on appearance rather than on dessert quality, and the fact that one variety may make a better flavored product than another is not considered. As a rule, a product of high commercial grade can be made from any sort which has a firm texture and bleaches to a satisfactory degree of whiteness. A variety of high dessert quality, such as the Northern Spy, may be expected to make an evaporated product of correspondingly high flavor.

In sections where the Baldwin apple is grown extensively it is in demand at the commercial evaporators, as it meets the requirements in a fair degree and it is also available in relatively large quantities. In the Ben Davis sections that variety supplies a similar demand.

Most early varieties lack sufficient firmness of texture for the best results and are undesirable on this account. On the other hand, some comparatively early sorts, such as Gravenstein and Yellow Summer Pearmain, are considerably prized in some sections; the dessert quality of the latter is especially high.

Similarly the product made from other sorts possesses qualities that are due more or less to varietal characteristics. For instance, that from Esopus is said to be unusually white; Hubbardston and varieties of the Russet group also make very white stock. The latter make relatively a large amount of stock, by weight, to a given quantity of fresh fruit. Limbertwig is said to produce from one and one-half to two pounds a bushel more of dried stock than most sorts do, but it is not as white as that from some other varieties.

Preparing the Fruit for Drying

Paring

No special comments are necessary under the head of paring, save to mention this step in the order in which it occurs in the preparation of the apples for drying. The apples are cored in the same operation by an attachment applied to the paring machine for this purpose. The fruit is automatically forced from the fork and drops to the table, where it is next taken in hand by the trimmers. In the smaller evaporators the slicing is often done at the time of paring by a slicing attachment applied to the parers.

In nearly all the evaporators the paring and trimming are done by women and girls.

Trimming

In paring the fruit there is usually more or less skin left around the stem and calyx of the apples and any irregular places that may occur. There will be wormholes, decayed spots, and other blemishes which will detract from the appearance of the product, if allowed to remain.

Even bruises are objected to by the most exacting operators. Hence all such defects are cut out as soon as the fruit is pared if the highest grade of product is expected. This is done with an ordinary straight-back, sharp-pointed knife, having a blade two and one-half or three inches long.

Bleaching

The fumes of burning sulphur are employed not only to make the fruit white where the freshly cut surfaces have become discolored by contact with the air, but to prevent further discoloration after it is sliced. Sulphuring is also generally supposed to be necessary to destroy fungi and insects, though under present methods of handling this is open to question.

There are no definite standards governing the bleaching as to the time required, amount of sulphur necessary to accomplish the desired end, etc. The aim is to treat until enough of the fumes have been absorbed by the apples to prevent discoloration after they are sliced and exposed to the air. If it is found that the fruit is not retaining its clean, white appearance with the treatment that is being given, either the length of time that the fruit is kept in the bleacher is increased or more sulphur is burned in the customary time for bleaching. Due caution should be exercised, however, in this connection, inasmuch as the bleaching of desiccated fruits with sulphur fumes is open to criticism. The sale of fruit containing sulphurous acid in any considerable quantity is prohibited by the pure food laws of some states, as well as being restricted in some of the foreign markets. The Federal pure food law will also make definite restrictions.

In many cases the bleaching process is doubtless continued much longer than is necessary for the desired results. Until some definite standards are established and recognized, the greatest care should be exercised not to bleach more than the minimum required to maintain the desired color a reasonable length of time.

The allotted time for bleaching in a large number of evaporators, from which information has been secured, varies from twenty minutes to one and one-half hours. The more usual time appears to be about forty-five minutes. This, however, may be regulated in a measure by the amount of sulphur burned in a given time.

The estimates regarding the amount of sulphur used to bleach a ton of fruit vary from four or five pounds to 20 pounds, though but little information of a definite character is to be obtained at present.

The usual practice is to start the sulphur fumes by putting a few live coals into the receptacle used for the purpose, then adding a small piece or two of stick brimstone. Before this has all been vaporized, more is added. This is continued as long as the bleacher is in operation, sufficient heat being generated to vaporize the sulphur without the further addition of burning coals.

When apples are dried whole, without slicing or quartering, they require less bleaching than if they are to be sliced, inasmuch as the interior of the fruit does not come in contact with the air.

For the most satisfactory results it is essential that the fruit be put into the bleacher in the shortest possible time after the surface is exposed to the air by paring. If a long delay occurs the surface becomes discolored, in which case it does not regain its original whiteness in the bleaching process.

Slicing, Quartering, Etc.

After bleaching, the next step in preparing the fruit is slicing, unless instead of slicing it is quartered or dried whole, as is done to a limited extent. In preparing fruit for some of the smaller evaporators, as previously mentioned, the slicing is done when the fruit is pared, the bleaching then follows the slicing instead of preceding it.

The slices are one-fourth inch in thickness, and in the largest degree possible should be cut at right angles to the hole made through the axis of the apple when the core is removed by the parer, thus producing the "rings," which is the form most desired. Other things being equal that fruit is sliced the best which contains the largest proportion of "rings," and this point is given more or less weight in grading the finished product.

When it is desired to evaporate apples

in quarters or sixths they are run through machines which cut them accordingly, the cutting being done in the opposite direction from the slicing; that is, in a direction parallel to instead of at right angles to the axis of the apple.

If they are to be dried whole, they are transferred from the bleacher directly to the drying compartment without further treatment.

Drying the Fruit

When the fruit has been placed in the drying compartment of an evaporator, of whatever type it may be, it has reached the most critical stage in the whole process of evaporation, and it is here that the greatest care and skill are required to insure the best possible results.

Capacity of Floor Space and Racks

In the case of kiln evaporators, the sliced fruit is evenly spread on the floor to the depth of from four to six inches. A kiln 20 feet square will hold the slices of from 120 to 150 bushels of fresh fruit, depending upon the amount of waste in the apples and the exact depth to which they are spread on the floor.

If the fruit is in quarters or is dried whole, it may be somewhat thicker on the floor, since in these forms it does not pack down as closely as the slices do and hence does not impede the circulation of hot air through it if the depth is somewhat increased.

In tower evaporators and other types where the fruit is handled on racks the slices are seldom placed much more than one inch in depth. A rack four feet square will hold from three-fourths of a bushel to a bushel.

The fruit is generally put on the floor of the kiln as fast as it is sliced, and the fire is started in the furnace below as soon as the floor is filled, or, in many cases, before it is entirely covered.

Oiling the Floors and Racks

It is common practice to treat the floor of kilns occasionally with tallow to prevent the fruit from sticking to it. This is done every few days, or as often as conditions appear to make it advisable. Sometimes a mixture of equal parts of tallow and boiled linseed oil is used for this purpose.

Another practice, with the same end in view, is to thoroughly scrub the floors as often as is necessary with water, using with it some one of the scouring soaps. This is preferred by some operators, who claim that oil or tallow discolors the fruit.

At each filling of the racks, where these are used, the surface of the wire netting is lightly wiped over with a cloth moistened in lard. This prevents the fruit from sticking to the netting and keeps it clean.

Temperature Maintained

The temperature maintained in kilns or other drying compartments, in actual practice, is largely a matter of experience, not a factor governed by any definite standards or regulated in accordance with thermometer readings, as might be expected. In general, the object in view is to force the heat as high as possible without endangering the fruit. A probable temperature which has been suggested by some of the operators is 150 degrees Fahrenheit, or more when the fruit is first put into the drying compartment, dropping to about 125 degrees Fahrenheit as the drying process nears completion. Sufficient and proper provision for controlling the indraft of cold air below the fruit will aid in maintaining the desired temperature.

Turning the Fruit

In order to prevent the fruit from burning and from sticking to the floor by remaining in contact with it too long, and to insure the most uniform drying that is possible, the fruit, in the case of the kiln driers, is turned occasionally. The interval between turnings varies with different operators, with the condition of the fruit, and with the degree of heat which is maintained. Some operators do not turn the fruit until five hours have elapsed after the furnace has been started, while a more common practice is to make the first turning within two or three hours after the drying is begun, or even sooner. For the first five or six hours it is generally turned every two hours or so, and more frequently as the fruit becomes drier, until perhaps it may require turning every half hour when nearly dry.

The objects to be obtained by turning must be kept in mind and the fruit handled accordingly. It should be examined from time to time and turned often enough to prevent scorching or sticking and to insure uniform drying.

In the case of the tower evaporators and other types in which the fruit is handled on racks, no turning more than an occasional stirring of the fruit with the hand or with a small wooden paddle is required. Sometimes the relative positions of the racks are changed to make the drying more uniform. This is one reason why the tower-dried fruit is generally of rather better quality than that from kilns. The repeated turning on the kiln floor is likely to make the fruit more or less "mussy," while in that which remains practically undisturbed on the racks the rings are maintained in better condition. The fruit also dries more quickly, and is often of better color than the kiln-evaporated product, and hence is more attractive in appearance.

The same general principles must be observed in tending the fruit where steam heat is used in place of direct hot air from furnaces.

Time Required for Drying

The time necessary for drying fruit depends upon several factors. The more important are: Type of evaporator; depth to which fruit is spread; method of preparing—whether sliced, quartered, or whole; temperature maintained; conditions of the weather, and, to a certain extent, the construction of the evaporator.

The application of these several factors to the point in question readily follows. A good kiln evaporator should dry a floor of slices, other things being equal, in about twelve hours, ten to fourteen hours being the range of variation. Where the fruit is handled on racks the time required is much shorter, but conditions are quite different from the kilns, as the fruit is seldom more than one or two inches thick on the racks. For slices, five hours is considered a reasonable time, with a range of four to six hours.

It is estimated that quarters will require from eighteen to twenty-four hours in the average kiln, while the time for whole apples will range from thirty-six to forty-eight hours.

If the atmospheric conditions are heavy and damp, the drying is retarded. Under some conditions it is hardly possible to thoroughly dry the fruit. During windy weather also it is more difficult to regulate the heat, especially if the walls are poorly constructed so that the draft of cold air into the furnace room can not be controlled. This applies especially to kilns heated by furnaces. It is claimed that steam-heated evaporators are less subject to the influence of climatic conditions.

When Is the Fruit Dry?

Perhaps there is no step in the entire process that requires better trained judgment than the matter of determining when the fruit is sufficiently dried to meet the requirements. Like several other steps in the process it is largely a matter of experience, though there are certain general features which are capable of being reduced to words.

The fruit should be so dry that when a handful of slices is pressed together firmly into a ball the slices will be "springy" enough to separate at once upon being released from the hand. In this condition there will be no fruit, or only an occasional piece, that has any visible moisture on the surface. In a slice of average dryness, it should not be possible to press any free juice into view in a freshly made cross section of it. The general "feel" of the fruit, as it is handled, should be a soft, velvety, leathery texture.

The foregoing should represent as nearly as possible the average condition, but it cannot be expected to be absolutely uniform throughout. Some slices—they should constitute only a very small percentage—will still plainly possess some of the juice of the apple; others—likewise, properly only a small proportion—will be entirely too dry, possibly dry enough to be brittle.

The Curing Room

When a quantity of fruit is considered dry enough, it is removed from the kiln and put in a pile on the floor of the curing room. Every day or two the pile should be thoroughly shoveled over to make uniform the changes which take place. Thus managed, the pile in a few days will become thoroughly homogeneous. The pieces that were too dry will have absorbed moisture, the superfluous moisture of other pieces will have disappeared, and the entire mass may be expected to reach the condition above described.

Handling the Waste

In the usual grades of apples that are taken to the evaporator there are many specimens that are too small to pare or which for other reasons can not be profitably used in this way. In the case of some of the larger evaporators which are operated in connection with vinegar factories, these apples, as well as all parings and trimmings, are used for "vinegar stock," but in the smaller ones these portions are usually dried. It is generally estimated that about one-third as much space is required to dry the parings and trimmings as is demanded for the "white fruit."

"Waste" and "chops" are generally bleached, but are seldom passed through the bleacher which is used for the white fruit. Where they are dried in kilns, which is usually the case, a common way of bleaching is to burn the sulphur in the furnace room after the stock has been spread on the floor.

It is generally estimated that the waste from a given quantity of apples will pay the cost of the fuel for evaporating that quantity of fruit; that is, putting it on a bushel basis, the waste from a bushel will pay for fuel to evaporate both the white fruit and the waste from that bushel. While in some instances, when the price of such stock is low, this estimate may be too high, it not infrequently happens that it more than pays for the fuel.

Weight of Evaporated Apples

Some varieties of apples will make more evaporated stock to the bushel than others. The grade used also affects the amount, but an average weight—a frequent basis of estimates—is about 6¼ pounds of white fruit and 3¼ pounds of waste to a bushel of fresh fruit. When the apples are dried whole, without slicing, they will make from one to two pounds more to the bushel than when sliced.

Handling Evaporated Apples

While comparatively few of the manufacturers of evaporated apples pack their own fruit for the trade, it will be of interest to them and of direct value to know something of the methods pursued by dealers, and especially in regard to grading and the requirements of the various grades.

The product of all grades is generally shipped to the dealers in gunny sacks having a capacity of one and one-half to two bushels. The "white fruit" is usually bought by the pound. Sometimes the waste is rated by the hundredweight. The price paid is not governed by the market conditions alone; the quality is an important factor.

Grading

In classifying evaporated apples, three grades are generally recognized which are commonly designated as "fancy," "choice," and "prime." Two other grades which in reality are special grades, are also sometimes recognized, viz.: "extra fancy," and a lower grade than prime—usually called prime with some prefix, frequently the name of a locality, to distinguish it from that grade.

The standards demanded for these various grades are about as follows:

"Fancy" is very white, clean stock, free from all pieces of skin and other objectionable portions which should be removed in trimming, and a good portion of the slices in rings.

"Choice" denotes a grade intermediate between "fancy" and "prime," not quite clean enough for "fancy," yet more nearly free from imperfections than the "prime" grade demands.

"Prime" must be good stock, well cured and of a generally attractive appearance. It must be comparatively white and mostly free from undesirable portions, but stock having a small percentage of such defects is usually put in this grade.

"Extra fancy," as the name implies, is a fancy grade that is exceptionally fine. It must possess all the qualities mentioned in describing that grade in a marked degree. At least 85 per cent of the slices should be "rings."

The grade below "prime" is the stock that has been so carelessly handled and is so unattractive in appearance that it cannot maintain the standard of "prime." It is packed for an entirely different and much poorer class of trade than any of the other grades.

Kinds of Packages Used

In packing the fruit, several sizes of packages are in common use. While the proportionate dimensions of the packages may vary with the different dealers and packers, their capacity is more or less a matter of uniform standards.

Perhaps the package most used is the 50-pound wooden box. A common form of this box is 10½ by 11 by 22 inches, inside measure. Twenty-five pound boxes are likewise much used; these are commonly made 9 by 9 by 18 inches, inside dimensions. A box holding 55 pounds of sliced fruit, having inside measurements of 11 by 11¾ by 22½ inches, is much used for the export trade. These are generally marked "25 kilos" when intended for export, instead of having the capacity designated in pounds.

Pasteboard cartons, holding one pound, or one-half kilo (1.1 pounds) for certain export trade, are also more or less used for the better grades of sliced fruit. These cartons are generally packed in a box or case, 48 cartons to the case. The cartons are 2 by 5 by 7 inches; the case is about 12 by 16 by 21 inches.

All of these packages are used as desired for slices or "rings," but the quarters and whole fruit are generally packed in the 55-pound boxes, which, however, are expected to contain but 50 pounds of fruit in these forms.

Packing

The side of the box intended for the top or "face" is packed first, as in packing fresh fruit in boxes or barrels. The first step in packing, therefore, is to "face" this side. The "facers" are slices which are perfect rings. These are usually selected from a quantity of fruit which contains a relatively large proportion of them; they are then placed on thin boards which are slightly smaller than the top of the box, inside measure, overlapping one another in rows, lengthwise of the board. The facers are put in place by inserting the board on which they are arranged into the box, which is first lined with paraffin paper, and then with a dexterous movement of the hand flipping the layer of rings against the inner face or the bottom, which is to become the top of the box.

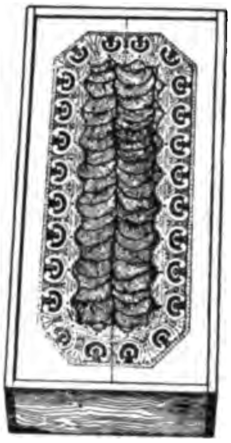

Fig. 3. A 50-pound Box of "Fancy" Evaporated Apples with Cover Removed.

A press is generally used in filling the boxes. Three men compose a packing gang for each press; one to fill the boxes and weigh the fruit; one to operate the press; a third to nail on the cover, which now becomes the bottom of the box.

In filling the boxes, an extension of the box upward is necessary, since 50 pounds of evaporated apples have to be compressed greatly in order to get them into a box of the required dimensions. This extension may be another box of same size with a rim nailed around the edge to fit over the box to be filled. The box is placed on a pair of scales and filled with the desired quantity of fruit, by weight; it is then passed to the press. A "follower" slightly smaller than the box is put in position over the fruit and this is pressed down until the fruit reaches the desired point.

Quarters and whole apples are handled in essentially the same manner except in regard to the facing. In facing whole apples they are placed on the side in rows lengthwise of the bottom (when packed, the top) of the box. The boxes are then filled the same as with slices. Quarters are handled in the same way.

Figure 3 is a box of fancy evaporated apples with cover removed, showing the paper lace used for decorative effect. Figure 4 is the same box with the paper covering entirely removed.

Cartons are filled by hand, the work usually being done on a table of convenient height. Each package is weighed to insure its proper content of fruit.

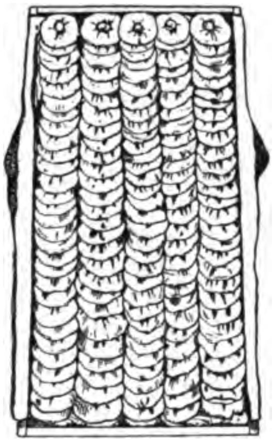

Fig. 4. A 50-pound Box of "Fancy" Evaporated Apples with Cover and Paper Lace Removed.

The sun-dried fruit, of which quite large quantities are handled by some dealers, is usually packed in sugar barrels. This is largely exported. The waste is also generally put into barrels, 240 to 250 pounds net usually filling a barrel. Chops are handled in a similar manner.

Storing the Fruit

In years of great abundance of apples, the evaporated product is likely to exceed the immediate demand. While fruit that has been well bleached and cured can be held for a considerable period of time without loss it is by no means imperishable. The color is first to deteriorate. The fruit appears to lose the effect of bleaching after a time and turns dark. Though it may retain its flavor for a long time, its unattractive appearance renders it more or less unsalable.

When it is desired to hold evaporated apples from one season to another, recourse is had to cold storage. Some seasons large quantities are handled in this way. The temperature at which it is stored is usually from 32 degrees to 35 degrees Fahrenheit, or about the same as for fresh fruit. If well bleached and properly cured it may be held for a relatively long period. Four or five years is said by commercial handlers to be about the usual limit of time before the color deteriorates. It is seldom, however, that it is desirable to hold the fruit for so long a time.

H. P. GOULD,
Assistant Pomologist, Bureau of Plant Industry, Washington, D. C.

Condensed from Bureau of Plant Industry Bulletin 291.

Experiment Stations

Alabama—College Station, Auburn; J. F. Duggar*; Canebrake Station, Uniontown; L. H. Moore*; Tuskegee Station, Tuskegee Institute; G. W. Carver*.

Alaska—Sitka; C. C. Georgeson†.

Arizona—Tucson; R. H. Forbes.*

Arkansas—Fayetteville; M. Nelson*.

California—Berkeley; T. F. Hunt*.

Colorado—Fort Collins; C. P. Gillette*.

Connecticut—State Station, New Haven; Storrs Station, Storrs; E. H. Jenkins*.

Delaware—Newark; H. Hayward*.

Florida—Gainesville; P. H. Rolfs*.

Georgia—Experiment, R. J. H. DeLoach*.

Guam—Island of Guam; J. B. Thompson†.

Hawaii—Federal Station, Honolulu; E. V. Wilcox†. Sugar Planters Station, Honolulu; H. P. Agee*.

Idaho—Moscow; W. L. Carlyle*.

Illinois—Urbana; E. Davenport*.

Indiana—La Fayette; A. Goss*.

Iowa—Ames; C. F. Curtiss*.

Kansas—Manhattan; W. M. Jardine*.

Kentucky—Lexington; J. H. Kastle*.

Louisiana — State Station, Baton Rouge; Sugar Station, Audubon Park, New Orleans; North Louisiana Station, Calhoun; W. R. Dodson*.

Maine—Orono; C. D. Woods*.

Maryland—College Park; H. J. Patterson*.

Massachusetts—Amherst; W. P. Brooks*.

Michigan—East Lansing; R. S. Shaw*.

Minnesota—University Farm, St. Paul; A. F. Woods*.

Mississippi—Agricultural College; E. R. Lloyd*.

Missouri—College Station, Columbia; F. B. Mumford*. Fruit Station, Mountain Grove; Paul Evans*.

Montana—Bozeman; F. B. Linfield*.

Nebraska—Lincoln; E. A. Burnett*.

Nevada—Reno; S. B. Doten*.

New Hampshire—Durham; J. C. Kendall*.

New Jersey—New Brunswick; J. G. Lipman*.

New Mexico—State College; Fabian Garcia*.

New York—State Station, Geneva; W. H. Jordan*. Cornell Station, Ithaca; W. A. Stocking, Jr.‡

North Carolina—College Station, West Raleigh; State Station, Raleigh; B. W. Kilgore*.

North Dakota—Agricultural College, T. P. Cooper*.

Ohio—Wooster; C. E. Thorne*.

Oklahoma—Stillwater; L. L. Lewis*.

Oregon—Corvallis; J. Withycombe*.

Pennsylvania—State College; R. L. Watts*. State College, Institute of Animal Nutrition; H. P. Armsby*.

Porto Rico—Federal Station, Mayaguez; D. W. May†. Sugar Planters, Station, Rio Piedras; J. T. Crawley*.

Rhode Island—Kingston; B. L. Hartwell*.

South Carolina—Clemson College; J. N. Harper*.

South Dakota—Brookings; J. W. Wilson*.

Tennessee—Knoxville; H. A. Morgan*.

Texas—College Station; B. Youngblood*.

Utah—Logan; E. D. Ball*.

Vermont—Burlington; J. L. Hills*.

Virginia—Blacksburg; S. W. Fletcher*. Norfolk, Truck Station; T. C. Johnson*.

Washington—Pullman; I. D. Cardiff*.

West Virginia—Morgantown; E. D. Sanderson*.

Wisconsin—Madison; H. L. Russell*.

Wyoming—Laramie; H. G. Knight*.

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* Director.
† Special agent in charge.
‡ Acting director.

Exposure. See *Apple Orchard, Selecting a Site For.*

Evaporation of Water. See *Irrigation.*

Farms

*Farm Value of Important Crops

(Average prices paid to producers in the United States.)

PRODUCT	Feb. 15, 1912	Jan. 15, 1912	Dec. 15, 1911	Nov. 15, 1911	Oct. 15, 1911	Feb. 15, 1911
Apples, per bu	$ 0.98	$ 0.93	$ 0.86	$ 0.73	$ 0.66	$ 1.19
Pears, per bu	....	....	1.11	.85	.97	....
Beans, per bu	2.38	2.38	2.42	2.34	2.27	2.23
Onions, per bu	1.40	1.17	1.13	1.03	1.02	1.04
Cabbage, per 100 lbs	2.24	1.89	1.83	1.51	1.58	1.48
Sweet Potatoes, per bu	.94	.87	.79	.76	.86	.82
Clover Seed, per bu	12.22	10.89	10.62	10.37	10.33	8.37
Timothy Seed, per bu	7.26	6.99	6.72	6.90	6.91	4.51
Cotton Seed, per ton	16.81	16.57	16.70	16.69	16.73	25.61
Horses, per head	137.00	134.00	134.00	136.00	137.00	144.00
Beef Cattle, per 100 lbs	4.61	4.46	4.37	4.36	4.32	4.57
Veal Calves, per 100 lbs	6.07	6.06	5.98	6.10	6.15	6.38
Milch Cows, per head	43.40	42.89	42.72	42.70	42.69	44.98
Sheep, per 100 lbs	4.01	3.89	3.71	3.65	3.68	4.34
Lambs, per 100 lbs	5.15	5.22	4.93	4.68	4.68	5.44
Hogs, per 100 lbs	5.79	5.74	5.72	5.86	6.09	6.93
Milk, per gallon	.232	.228	.222	.218	.213	.221
Wool, unwashed, per lb	.163	.162	.155	.156	.155	.173
Honey, comb, per lb	.140	.138	.138	.136	.137	.133
Bran†, per ton	28.62	27.39	26.99	20.72	....	25.27

† Price to Feeders.

* From Crop Reporter, March, 1912.

* Farm Wages

The average wages of farm labor in the United States, as reported by correspondents of the Bureau of Statistics, Department of Agriculture, for years indicated, was as follows:

Year ending June 30, 1911.

YEAR	Wages of Farm Labor, when employed by—					
	Month		Day, at harvest		Day, other than harvest	
	Without Board	With Board	Without Board	With Board	Without Board	With Board
1911	$28.77	$20.18	$1.85	$1.49	$1.42	$1.09
1910	27.50	19.21	1.82	1.45	1.38	1.06
1902	22.14	16.40	1.53	1.34	1.13	.89
1899	20.23	14.07	1.37	1.12	1.01	.77
1898	19.38	13.43	1.30	1.05	.96	.72
1895	17.69	12.02	1.14	.92	.81	.62
1894	17.74	12.16	1.13	.93	.81	.63
1893	19.10	13.29	1.24	1.03	.89	.69
1892	18.60	12.54	1.30	1.02	.92	.67
1890	18.33	12.45	1.30	1.02	.92	.68
1888	18.24	12.36	1.31	1.02	.92	.67
1885	17.97	12.34	1.40	1.10	.91	.67
1882	18.94	12.41	1.48	1.15	.93	.67
1879	16.42	10.43	1.30	1.00	.81	.59
1875†	19.87	12.72	1.70	1.35	1.08	.78
1869†	25.92	16.55	2.20	1.74	1.41	1.02
1866†	26.87	17.45	2.20	1.74	1.49	1.08

† In currency.

* From Crop Reporter, March, 1912.

KEEPING OUR CHILDREN ON THE FARM

There is only one way known to the writer to keep children on the farm, after they reach their majority, and that is to make the farm attractive. In order to make it attractive, it must be made financially profitable, and socially pleasant. How to make the farm as profitable as other lines of business, is the problem. In order to be made profitable, its products must yield as much money, for a given amount of labor, as other lines of business. If the farm can be made to supply these needs, our young people will not desire to leave it, but if it cannot, they will continue to crowd into the cities for the purpose of making money, and obtaining social privileges they cannot obtain in the country.

The days of social isolation are practically past, except for a limited number of persons, who care little for education, entertainment, and the gratification of the social instincts. The farmer generally tries to educate his family. Even though he has not the advantages in the sparsely settled districts he sends his children to high school, and often to college, during which period they come into contact with the world in a broader way than ever before, and develop some kind of social life not possible on the farm. Education has created wants and if the farm will not furnish the means and opportunities to supply them, the best educated of our young people will leave the farm.

It is a fact that with the present status of our industrial development, the farm does not produce enough to supply the wants of an educated citizenship. Statistics show that the average farm, in the United States, yields less in net profits than the average wage worker receives. Yet the average farm requires an investment of over $6,000 for land, stock and farm machinery. So long as it is true that the average wage worker, with no investment at all, can live in town and receive for his year's labor as much as the average farmer receives with his $6,000 investment, it will be impossible to keep our best, most educated and spirited young people on the farm.

The tendency has been to build up our manufacturing, mining, and commercial industries by bonuses, subsidies, tariffs, land grants and other devices, disproportionately when compared to the importance and extent of the wealth produced and the number of persons employed on farms. The tendency is now to give more attention to the farm, to educate the farmer as to the best methods of production, to show how larger crops can be produced for a given amount of labor, and how greater profits may be obtained without raising the cost to consumers.

It is a fact that work on the farm is conducted with less system, and less scientific analysis of all the factors involved, than most other lines of business. Comparatively few farmers keep anything like correct book accounts of the expenses and income of the various departments of farm work. Few have any idea as to the best methods of soil conservation for the various kinds of crops, and how to leave to their children land as rich or richer than they found it, and fewer still seem to recognize the value of a proper cultivation of social life.

The isolation of farm life is being, in part, overcome by the use of automobiles which, on account of the rapid travel, seems to shorten the distances between places. But the ownership of automobiles implies more than average conditions on the part of the owners. It implies an additional expenditure for good roads. This means that the farm must be made sufficiently profitable to pay for all these expenses.

Generally a fruit growing district yields more wealth, in proportion to a given area, than a country devoted to other kinds of production. It would probably be easier therefore for fruit growers to live on smaller tracts of land, live in closer relations to each other, have better roads, more modern improvements and better social life than farmers in general; but it is nevertheless a question largely of financial profit, which must be worked out in a more scientific way than formerly.

Granville Lowther

MINOR ARTICLES OF FARM EQUIPMENT

Few farmers realize the extent of their investment in small items of equipment or the time and inconvenience involved in buying numerous articles singly or in small lots. Before planning the farm equipment, due consideration should be given to the necessary outlay for minor items, and where possible the latter should be secured at one purchase, thereby saving time and, usually, money. The purchase of these articles in such a manner will mean a total expenditure sufficient to impress the farmer with the need for their systematic care. The minor items for a general farm of 160 acres in the Middle Western states will probably cost from $200 to $300.

The lists given below are in the nature of a census in that they present data from which each individual may secure the information suited to his own use. These lists are printed with that object in view rather than as a recommendation of what should be purchased. Farmers' Bulletin 347, following a discussion of the various workshop tools, states that the complete equipment of a shop for the making of general farm repairs should include a blacksmithing outfit, a $25 collection of wood working and general purpose tools, a pipe working combination, miscellaneous tools, a harness repair outfit, a work bench, a pair of saw horses, and a grindstone, and that this entire equipment for a shop can be secured for about $100 in a fair quality of goods, while for $150 tools of excellent quality can be obtained.

The great number of general purpose items, other than those mentioned, together with those for use in connection with the producing enterprises, and the stock of materials needed for the repair of farm equipment will easily bring the total cost of a good working equipment in miscellaneous articles up to $250. The expenditure of this sum for this purpose in the organization of the farm is probably out of the question for many farmers, but due consideration at the outset for the necessary investment in minor items will save much inconvenience and disappointment later.

Table I

Summary of items of minor equipment, with the number and cost of all items suggested as necessary and their total cost.

	1	2	3	4	5
ITEMS	Percentage of farms reporting	Average number of items per farm reporting	Number of each item suggested as necessary	Cost of each item	Total cost of items suggested as necessary
General purpose:					
Auger	67	3.0	3	$0.25	$0.75
Awl	27	1.9	1	.10	.10
Ax and handle	88	2.1	2	1.25	2.50
Pinch bar	64	1.1	1	.75	.75
Bench screw	55	1.0	1	.60	.60
Auger bit	94	6.7	7	.30	2.00
Bit brace	94	1.2	1	1.50	1.50
Steel square	85	1.1	1	.75	.75
Bevel square	35	1.0	1	.40	.40
Try-square	25	1.0	1	.25	.25
Wood chisel	73	4.3	4	.40	1.50
Compass	42	1.0	1	.30	.30
Level	64	1.2	1	.75	.75
Drawing knife	91	1.3	1	.75	.75
Scratch gauge	45	1.4	1	.40	.40
Gimlet bits	55	3.0	2	.20	.40
Grub hoe	21	1.1	....	.50	....
Claw hammer	82	1.3	1	.50	.50
Hand ax	36	1.0	1	.50	.50
Hatchet	70	1.4	1	.75	.75
Screw-driver	67	1.7	1	.25	.25
Log chain	82	2.5	2	1.50	3.00
Wooden mallet	36	1.5	1	.25	.25
Mattock	79	1.4	1	.75	.75
Compass saw	42	1.0	1	.30	.30
Handsaw	94	1.7	2	1.25	2.50
Crosscut saw, large	85	1.2	1	3.00	3.00
Plane	73	2.3	2	1.25	2.50
Iron wedge	79	2.5	2	.30	.60
Tapeline	39	1.1	1	.50	.50
Rasp	39	1.1	1	.50	.50
Brush hook or scythe	21	1.0	....	1.25	....
Cant hook	42	1.4	1	1.25	1.25
Chalk line	27	1.0	1	.10	.10
Buck saw	10	1.0	....	.75	....
Carpenter's pincers	30	1.2	1	.60	.60
Anvil	21	1.0	....	10.00	....
Vise	15	1.2	....	5.50	....
Forge	3	1.0	....	16.00	....
Combination drill press	23	1.0	1	4.00	4.00
Drills	27	3.9	4	.50	2.00
Tinner's snips	18	1.0	....	1.25	....
Cold chisel	73	2.3	2	.20	.40
Whetstone	24	1.8	1	.10	.10
Screw plate	27	1.0	1	10.00	10.00
Tongs	6	2.0	....	.50	....
Flat file	70	2.0	2	.15	.30
Round file	35	1.5	1	.30	.30
Taper file	42	2.2	2	.10	.20
Oil can	30	1.7	1	.10	.10
Machine oil	61	*.8	*1	.30	.30
Pipe wrench	24	1.3	1	1.50	1.50
Monkey wrench	64	2.1	2	.50	1.00
Tool grinder	30	1.0	1	3.00	3.00
Grindstone	91	1.0	1	4.00	4.00
Riveting hammer	39	1.5	1	.75	.75
Sledge hammer	33	1.1	1	1.00	1.00
Pliers	67	1.4	1	.50	.50
Nippers	52	1.5	1	1.00	1.00

*Gallons.

Table I—Continued

Summary of items of minor equipment, with the number and cost of all items suggested as necessary and their total cost.

ITEMS	1 Percentage of farms reporting	2 Average number of items per farm reporting	3 Number of each item suggested as necessary	4 Cost of each item	5 Total cost of items suggested as necessary
General purpose—Continued:					
Punch	33	2.2	2	$ .15	$ .30
Hack saw	18	1.0	....	.50	....
Saw-set	36	1.0	1	.60	.60
Maul	16	1.0	....	.60	....
Post-hole digger	41	1.5	1	1.25	1.25
Wire splicer	11	1.3	....	1.00	....
Wire stretcher	29	1.1	1	1.00	1.00
Ditch cleaner	22	1.0	1	1.25	1.25
Tile spade	31	1.6	1	1.00	1.00
Brick trowel	44	1.4	1	.40	.40
Plastering trowel	6	1.0	....	1.00	....
Sand sieve	16	1.4	....	.50	....
Pick	31	1.9	1	1.00	1.00
D-handled shovel	31	1.4	1	1.00	1.00
Long-handled shovel	13	1.3	....	1.00	....
Counter scale	16	1.0	....	5.00	....
Spring balance	34	1.1	1	.50	.50
Steelyards	28	1.1	1	2.00	2.00
Platform scale	38	1.0	1	8.00	8.00
Rat trap	24	1.0	1	.50	.50
Steel trap	26	2.1	1	.15	.15
Jackscrew	3	5.0	....	2.00	....
Stepladders	45	1.4	1	1.75	1.75
Ladder	52	1.4	1	2.00	2.00
Farm bell	58	1.0	1	2.00	2.00
Lantern	68	1.8	2	.90	1.80
Hoisting block	16	1.2	....	2.00	....
Barrel	71	3.0	3	.75	2.25
Padlock	39	1.8	1	.40	.40
Paint brush	48	3.3	2	.30	.60
Whitewash brush	26	1.4	1	.75	.75
Basket	52	5.8	4	.30	1.20
Household and farm:					
Lard press and sausage stuffer	45	1.0	1	5.50	5.50
Sausage grinder	48	1.0	1	2.00	2.00
Hog scraper	10	2.8	2	.10	.20
Hog hook	29	1.1	1	.05	.05
Butcher knife	52	2.4	2	.30	.60
Kettle	55	1.7	1	2.50	2.50
Tree pruner	15	1.2	....	1.50	....
Pruning shears	39	1.3	1	.40	.40
Crates	39	54.7	40	.40	16.00
Garden rake	64	1.2	1	.50	.50
Hoe	88	2.4	2	.40	.80
Cultivator	12	1.3	....	4.00	....
Trowel	12	1.3	....	.25	....
Cold frame	3	8.0	....	2.50	....
Flat	3	3.0	....	.10	....
Spade	36	1.4	1	.75	.75
Sprinkler	21	1.1	....	.50	....
Lawn mower	64	1.0	1	4.00	4.00
Lawn rake	21	1.0	....	.40	....
All stock:					
Broom	9	2.0	....	.30	....
Clipping machine	15	1.0	....	6.00	....
Manure fork	42	2.6	2	.70	1.40
Pail	27	4.4	3	.15	.45
Tie chain	18	5.3	3	.25	.75
Tie rope	9	2.3	....	.25	....
Hand sprayer	12	1.0	....	.75	....
Wheelbarrow	42	1.4	1	4.00	4.00
Horse and driving:					
Bit	40	2.4	2	.40	.80
Blanket	91	2.8	3	2.00	6.00
Brush	89	2.0	2	.50	1.00
Currycomb	89	2.3	2	.25	.50
Collar	43	2.7	2	3.00	6.00

Table I—Continued

Summary of items of minor equipment, with the number and cost of all items suggested as necessary and their total cost.

	1	2	3	4	5
ITEMS	Percentage of farms reporting	Average number of items per farm reporting	Number of each item suggested as necessary	Cost of each item	Total cost of items suggested as necessary
Horse and driving—Continued:					
Harness oil	34	‡1.5	‡2	$ .25	$ .50
Fly nets	34	2.8	2	1.00	2.00
Halters	97	6.5	6	.75	4.50
Muzzle	26	1.8	2	.20	.40
Nosebag	14	1.4	......	.50	......
Sweat pad	37	2.2	2	.35	.70
Harness punch	69	1.2	1	.50	.50
Riveting machine	69	1.0	1	.50	.50
Rivets	43	†1.2	†1	.10	.10
Tie rope	31	2.8	2	.15	.30
Saddle	57	1.0	1	10.00	10.00
Riding bridle	23	1.3	1	1.00	1.00
Snaps	23	7.4	4	.05	.20
Sponge	14	2.0	1	.10	.10
Neck straps	43	1.9	1	.75	.75
Syringe	23	1.1	1	.60	.60
Storm apron	17	1.2	1	.75	.75
Buggy jack	40	1.1	1	.75	.75
Wagon jack	14	1.0	......	1.00	......
Clevis	40	4.3	3	.10	.30
Chamois skin	11	1.0	......	.50	......
Dust robe	62	1.2	1	1.00	1.00
Lap robe	71	1.6	1	5.00	5.00
Evener, 2-horse	60	2.0	2	1.50	3.00
Evener, 3 or 4-horse	63	1.5	1	2.00	2.00
Storm front	46	1.1	1	4.00	4.00
Dash lantern	23	1.4	1	1.00	1.00
Neck yoke	14	1.6	1	1.00	1.00
Whippletree	29	3.1	2	.30	.60
Whip	60	1.4	1	.50	.50
Whisk broom	11	1.0	......	.10	......
Cattle:					
Cow bell	6	1.5	......	.25	......
Calf muzzle	3	1.0	......	.20	......
Crate	3	1.0	......	.50	......
Tie rope or chain	39	3.9	3	.30	.90
Dehorning clipper	9	1.0	......	5.00	......
Milk tube	15	1.0	......	.25	......
Dairy:					
Milk can	36	4.9	4	1.50	6.00
Milk crock	27	9.9	7	.10	.70
Milk pan	6	5.0	......	.20	......
Milk pail	70	3.2	3	.50	1.50
Churn	45	1.1	1	4.00	4.00
Butter crock	21	10.1	6	.20	1.20
Butter bowl	21	1.0	......	.50	......
Butter scales	6	1.0	......	1.50	......
Strainer	30	1.0	1	.50	.50
Skimmer	6	1.0	......	.10	......
Thermometer	24	1.0	1	.25	.25
Sheep:					
Bell	12	5.0	3	.15	.45
Shears	48	1.6	1	1.00	1.00
Swine:					
Ring plier	58	1.1	1	.20	.20
Rings	......	......	†1	.10	.10
Snout clipper	3	1.0	......	.40	......
Tongs	3	1.0	......	.50	......
Crate	15	2.0	......	1.00	......
Portable house	39	6.6	5	4.00	20.00
Poultry:					
Fountain	6	3.5	......	.25	......
Feed hopper	3	3.0	......	.25	......
Trap nests	3	8.0	......	.25	......
Feed pan	3	6.0	......	.05	......
Feed sieve	3	1.0	......	.25	......

‡Quarts. †Boxes.

Table I—Concluded

Summary of items of minor equipment, with the number and cost of all items suggested as necessary and their total cost.

ITEMS	1 Percentage of farms reporting	2 Average number of items per farm reporting	3 Number of each item suggested as necessary	4 Cost of each item	5 Total cost of items suggested as necessary
Poultry—Continued:					
Hover box	3	6.0		$ .25	
Egg tester	6	1.0		.15	
Coop	3	3.0		3.00	
Leg bands	6	50.5			
Bone cutter	6	1.0		6.00	
Bees:					
Foundation	6	•6.0		.75	
Section box (100)	12	2.8		.75	
Foundation fastener	9	1.0		.75	
Hive	15	19.6		1.00	
Super	12	30.3		.50	
Smoker	12	1.0		1.00	
Bee escape	6	2.0		.25	
Bee veil	9	1.3		.10	
Honey crate	6	13.5		.25	
Honey extractor	6	1.0		3.50	
Corn:					
Shock tier	27	1.0	1	.50	$ .50
Knife	70	2.7	2	.25	.50
Hand planter	61	1.3	1	1.50	1.50
Ensilage fork	6	1.0		1.00	
Seed tester	42	1.5	1	.50	.50
Seed rack	9	1.3		1.00	
Husking peg	30	2.9	2	.10	.20
Husking gloves	12	•1.3		.75	
Hay:					
Stack cover	3	2.0		8.00	
Carrier	30	1.1	1	3.00	3.00
Hoisting fork	58	1.1	1	1.25	1.25
Pulleys	55	4.5	4	.40	1.60
Hay rope, 1-inch	61	x132.5	•110		5.00
Trip rope, ½-inch	30	x 65.0	• 40		.45
Hand fork	88	3.2	3	.60	1.80
Baled hay hook	21	1.6	1	.30	.30
Scythe and snath	88	1.4	1	1.25	1.25
Hand seeder	70	1.1	1	5.00	5.00
Sickle	32	1.1	1	.50	.50
Slings	9	2.7		2.00	
Knife	67	1.2	1	.75	.75
Small grain and seed:					
Cradle	48	1.0	1	5.00	5.00
Binder cover	36	1.0	1	3.00	3.00
Flail	15	1.6			
Measure	33	1.4	1	.50	.50
Straw fork	15	1.2		.70	
Hand rake	36	1.3	1	.25	.25
Sacks	97	38.6	38	.20	7.60
Scoop shovel	82	1.7	2	1.00	2.00
Sugar beets:					
Beet fork	3	2.0		1.50	
Beet hoe	3	6.0		.50	
Beet topper	3	9.0		.25	
Potatoes:					
Scoop	3	1.0		1.50	
Fork or hook	39	1.4	1	1.50	1.50
Hand planter	3	1.0		1.75	
Maple sugar:					
Sap bucket	21	471.0		.20	
Spout	15	485.0		.03	
Cover	3	500.0		.06	
Scoop	12	1.0		1.00	
Gathering pail	12	2.5		.75	
Tapping bit	9	2.0		.30	
Total cost of items suggested as necessary					$270.70

xFeet. •Pounds. •Pairs.

WATER SUPPLY FOR THE FARM HOME

The failure to employ modern methods of lightening labor inside the house is a great hardship on many farms. Thoughtfully planned, conveniently arranged, and carefully constructed buildings are as essential in the country as in the city. Plumbing is becoming a necessity, not only for comfort and convenience but even more for health and cleanliness; and the proper disposal of the wastes of the household should not be neglected.

For domestic purposes the water must be clear, pure, and palatable; the essentials being freedom from disease germs, turbidity, color, odor and taste.

Springs and Wells

Of the various sources of supply springs usually rank first and deep wells next in desirability. The character of the water in a shallow well depends upon its past history and present environment. If it has traveled long distances through the soil without encountering organic impurities or taking up objectionable mineral salts, or if after possible pollution it has been filtered and purified in its travels, its quality is probably excellent. But shallow wells near barnyards or privy vaults should always be regarded with suspicion. It is well to remember that the price of pure water, wherever you go, is everlasting and unremitting vigilance.

To locate a cesspool and a well on the same small piece of ground is almost impossible without contaminating the water. Slop water of any kind should never be thrown near the well. The top 4 or 5 feet of the well casing should be laid in cement mortar to prevent water flowing in without first filtering through the ground. A sewer pipe or waste drain near a well is dangerous because such a pipe or drain is seldom watertight. If a sewer pipe must be run near a well, cast iron pipe should be used.

The carelessness that will locate the barn on higher ground than the well and take no precautions to divert the surface drainage is almost as deplorable as the use of the cesspool or privy vault. To keep the earth clean in the vicinity of the water supply is of the greatest importance and requires constant watchfulness.

Water Storage

Cisterns

There are localities where the only available water supply is obtained by storing the water which falls from the roof of the house during rainy weather. In other places the water is so hard that rain water is desirable in the laundry and bathroom.

Construction

The size of the cistern needed will vary with the size of the family, the length of the dry season, and the number of plumbing fixtures supplied with the rain water. This cistern may be located close to the house for convenience and should be added by building an 8-inch wall not less than 8 inches in thickness, laid in Portland cement mortar. The bottom should be laid with two courses of brick well bedded in the cement mortar. If the water is to be used for drinking or for cooking, a filter chamber should be added by building an 8-inch partition wall after the bottom has been paved. This wall should be built a little higher than the outlet of the overflow pipe. The walls of both compartments should be plastered with a good coat of cement mortar, composed of one part good Portland cement and two parts clean, sharp sand, excepting 10 or 12 inches of the bottom of the partition wall (4 or 5 courses of brick, which are laid together without cement) for the water to pass through. The water from the roof is collected in one compartment and is pumped from the other, the filtering material being put in the first compartment. An overflow pipe should be provided on the side of the cistern which the water enters, the opening of the overflow pipe being fitted with a fine strainer to exclude insects or vermin. A cut-off should be placed on the rain water pipe leading to the cistern to divert the flow to the outside when necessary, as, for instance, for a short time at the beginning of the rains to exclude the dirt collected on the roof and in the gutters.

The cistern may be built of concrete, and may be either round or rectangular. The round form is the more difficult to build, but it is the stronger.

Use of a Pump

A small force pump, placed at one end of the kitchen sink, with the suction pipe reaching to the cistern, is a convenient means of getting the soft water supply if the more expensive method of using a gravity tank or a pneumatic tank and piping the soft water to the sink, wash basins, and bath tub is not desired. If a gravity soft water tank is placed in the attic it can have a direct connection with a rain water leader which will keep the tank full during the rainy season. This conection must be supplied with an automatic cut-off which will send the water to the cistern when the attic tank is full. The force pump can be connected to the tank and used to fill it in dry seasons.

To have a constant water supply in the kitchen and bathroom it is necessary to have some means of storing it under pressure. An elevated tank which will deliver the water by gravity may be used, or a pneumatic tank which will deliver it by air pressure. The labor saved by having the water carried to the house, barn and garden, will soon pay for the storage tank, while the value of adequate fire protection and the healthfulness of sanitary plumbing can not be estimated in dollars.

Elevated Tanks

Location of the Tank

If the gravity system is chosen, the tank for the storage of the water may be in the attic or on an outside tower. If a windmill is used for power, a small tank can be supported 20 to 40 feet from the ground, on the same tower. These tanks can be constructed of wood or of galvanized steel, and of capacity varying from 300 to 2,000 gallons. If a larger tank is desired, a tank on an independent tower should generally be used with pipe connections to house and barns. When the storage for the house supply is in the attic, too large a tank should not be used, as water is heavy (62.5 pounds per cubic foot) and there is danger of overloading the attic floor unless it has been especially designed to carry the tank.

Kinds, Construction and Cost

Attic tanks are constructed of wood lined with zinc or lead, of galvanized steel, of cast iron, and of wrought iron. Such tanks should always be provided with an overflow pipe to carry off the water if the float valve fails to shut it off when the tank is full. If of iron or steel, a galvanized steel tank pan with a drain connecting with the overflow pipe should be placed beneath the tank to prevent damage to floors and ceilings from condensation of moisture on the outside. The water supply is regulated by means of a float valve which cuts off the inlet pipe when the tank is full enough. The size of the tank will be regulated by the power used to raise the water as well as the amount required by the family. The hydraulic ram or the windmill will require only a small storage tank, as they are so easily set going. If an engine is used, a tank that will hold a two or three days' supply would be more convenient and economical. A closed steel tank, fitted with a water seal air valve, may be used in the attic with the overflow pipe leading to the stock tank in the barnyard. This insures a constant renewal of the water. There is one farm in Illinois where the water supply is forced to an attic tank and the fall of the surplus operates a water motor for lifting the cistern water to another tank in the attic, and then the surplus water goes to a tank in the hay mow of the barn with an overflow pipe to a stock tank in the barnyard. This illustrates how well the head can be made to save the heels.

If all the plumbing fixtures are on the ground floor, the closed steel tank for the cold water supply can be placed in the kitchen or bathroom. If desired, the entire water supply can be made to pass through this house tank and so the house supply will be always fresh. With a closed tank there is no danger from overflow.

A tank like this, 12 inches in diameter and four feet high, will hold 24 gallons and cost about $16. An open galvanized steel tank can be made or can be bought ready made. A ready made one with a capacity of 100 gallons will cost about $8, while a 500-gallon tank will cost about $16.

Pneumatic Tanks

Sufficient pressure to force a water supply wherever desired in a farmhouse may be secured at all seasons by means of a pneumatic tank built of steel plates and located in the cellar, or in a small building erected over the well, or even buried in the earth if desired. It is superior to an elevated tank because the pipes and tank can more easily be made frost proof in winter and the water will be cooler in summer. It is closed to dust and light and has the additional advantage of resting upon the solid ground.

Principle of Action

Water is pumped into the bottom of this air-tight tank, and as the water rises in the tank the air above it is compressed. The expansion of this compressed air will force the water through the supply pipes at the bottom of the tank to points where the water is required. The pressure is increased by pumping more water into the tank and decreased by drawing water off. A 15-pound pressure will raise water to a height of 33 feet, a 10-pound pressure to a height of 22 feet, etc. The correct amount of air can be supplied and maintained by an automatic air valve, by a pump that forces both air and water into the tank at the same time, or by a hand air-valve. The last method is not self-regulating, but if water is supplied to the tank by a hand force pump, it will not require much more attention to regulate the air pressure also.

Power; Cost

The water can be forced into the pneumatic tank by the same means required to elevate it to a gravity tank, i. e., by a windmill, gas engine, hot-air engine, hydraulic ram, or by hand. From ten to

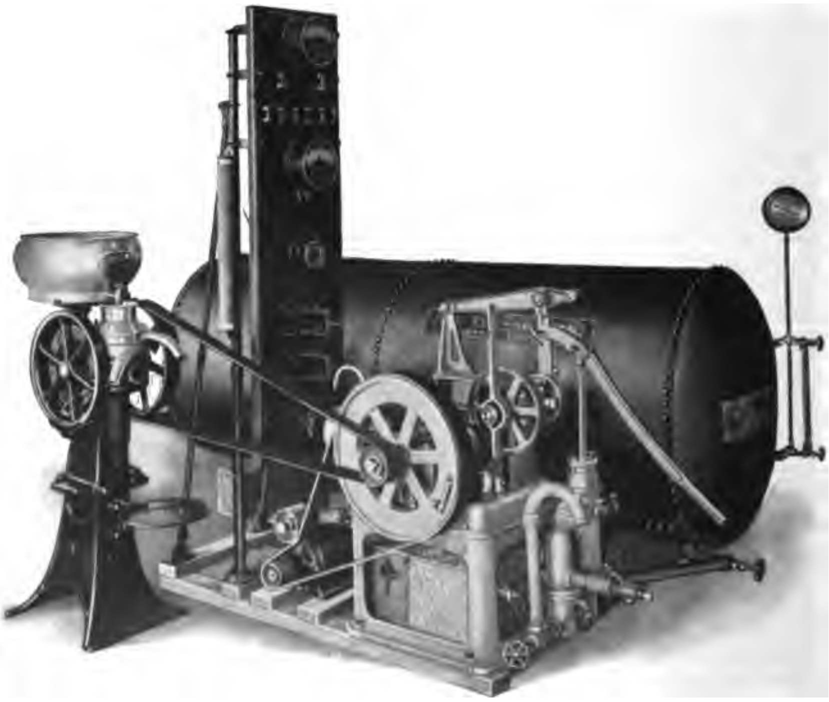

Fig. 1. Pneumatic Pressure Tank Showing Pump and Separator Operated by an Electric Motor.

—*Courtesy Kewanee System.*

twenty minutes a day with a good hand force pump will furnish a moderate supply. If more than 100 gallons a day are required, it is better to use some other means of pumping. If an engine is used, a large tank is more economical, and twenty minutes' pumping twice a week should furnish the supply. With a windmill an automatic regulator should be used, which will throw the windmill out of gear when the pressure reaches a given amount and start it again when the pressure is relieved.

The prices vary with the different manufacturers. A tank 30 inches in diameter and 10 feet long, which would supply the needs of a family of five, is listed at from $101 to $138 (subject to discount). The expense for repairs to an outfit like this is very slight and the time required for pumping varies with the power used.

Neighbors can frequently combine and put in one large plant for supplying water to several houses. This decreases the cost to the individual and gives a greater pressure in case of fire. The greater the horizontal distance the water is carried, the larger the pipes should be to lessen the loss of pressure by friction.

Power Available

What will be the most convenient and economical means of forcing water into the storage tank depends upon the situation in each case. The source of the supply, the amount required, the need of power for other purposes, the available fuel, and the cost of labor will all have a bearing on the matter. The hydraulic ram and the windmill have the advantage of operation without fuel, but the ram requires at least 18 inches of waterfall, while with the windmill the daily supply of water is not always subject to control. The gas or hot-air engine requires fuel and attendance, but the supply is more easily regulated.

The Hydraulic Ram

The hydraulic ram can be used to fill the storage tanks if the source of supply is a spring, flowing well, or running stream from which enough fall to supply the power can be obtained. Its use is practicable with a fall of only 18 inches, but with greater heads water can be forced to higher elevations and to longer distances. The head can be increased by damming the stream or by sinking the ram into a pit, if a drain can be secured to keep the pit free from water. The relation between the height of the spring, or source of supply, above the ram and the elevation to which the water is to be delivered determines the proportion of water raised to water wasted. It is not economy to increase the fall more than is necessary to supply the required amount of water, as the durability of the ram will be lessened. The amount of water procured by means of a ram from a very small fall makes a good supply because the ram is always going.

Windmills

The cost of installing a windmill will depend upon the depth and character of the well and its distance from the house and barns, upon the height of the tower, upon the elevation or pressure of the storage tank, and upon the amount of water required each day. These items vary so much with the individual cases that it is unsatisfactory to attempt to give even general figures. Any manufacturer of windmills will furnish an estimate upon application.

Gas or Hot-Air Engines

Small gas or hot-air engines are now manufactured for the express purpose of pumping water from cisterns, springs, or wells to elevated or pneumatic tanks to furnish supplies for houses and barns. One advantage of the engine over the hydraulic ram or the windmill is that the water can be pumped when it is wanted, and the size of the storage tank can be more accurately determined. An engine can be selected which will burn any kind of fuel—natural gas, gasoline, kerosene, coal, or wood. Such engines do not require an expert to run them, and, like the power windmill, can be used for driving other light machinery when not needed for pumping water.

The arrangement of the pipes to carry the water is governed by the same conditions as when other power is used. No more elbows or sharp bends should be used than are absolutely necessary, as they cut down the capacity of the engine; and when the water is to be pumped through a great length of horizontal pipe it is well to increase the size of the pipe.

The cost of a two or three horsepower engine will be from $60 to $130. The cost of the fuel is very small, as a half hour's pumping a day will furnish the average supply of water.

The House

Location

In selecting a location for a house there are certain points that should be held in mind. A slight elevation, having proper surface drainage, with protecting hills or woods on the north, is greatly preferable to a narrow valley, a low meadow, or the north side of a hill. The house should face so as to get sunlight into all the rooms, if possible, for "where sunlight does not enter the doctor must." This may be accomplished by facing the house southeast, for example, instead of directly east or south.

Foundation and Cellar

After the selection of the site some study should be given to the character of the subsoil, the principal factors to be considered in this connection being the water and the air. There is a certain amount of moisture in the upper layer of the soil which is the cause of damp and unhealthy foundations. This dampness is derived mostly from the surface water, and is directly proportional to the absorptive power of the soil and can be diminished by tiling and trenching. The ground air is rendered impure by the gases arising from the decomposition and putrefaction that are constantly going on in the soil, especially in that which is contaminated by household wastes.

In the construction of the cellar the first thing is to provide such drainage as will draw off the water at least one foot lower than the surface of the cellar floor and prevent the ground air from passing through the walls and floors. In building the cellar walls every joint should be entirely filled with mortar. A good coat of asphalt over the outside of the wall turned in at the grade line with a course of slate or bluestone above the ground level will prevent all soaking up of moisture. If a drain tile is laid just outside the footing course and the space on the outside of the wall is filled with sand and gravel all the way up to grade, the surface water will be carried away through the drain.

The floor of the cellar is best made by a layer of brick or of cinder concrete, covered by a layer of asphalt and finished by a 4-inch layer of stone concrete. A layer of well-beaten clay makes a good cellar floor, but it can not be so easily kept clean. The height of the cellar walls above the ground is important. They should extend a sufficient distance above the ground to admit of windows in the cellar at least 2 feet high. This will insure plenty of light and thorough ventilation. There should be cellar windows on all sides of the house.

Plumbing

Important Points to Be Kept in Mind

There is a great difference of opinion among those who have made special study of sanitary plumbing concerning many of the details of construction and design, but the vital things to be kept in mind when laying out the system are to use the best material, isolate all plumbing, and concentrate as much as possible. By "best material" is not meant the most expensive, but the most durable. Secure simplicity in all needed fixtures. Avoid complications in waste pipes. Select sinks without grease traps, bath tubs without inaccessible overflows, wash basins free as possible from fouling places, and water-closets without valves, connecting rods, or machinery.

The drainage system must be so constructed as to carry away completely, automatically, and immediately everything that may be delivered into it. It should be constantly and generally vented, frequently and thoroughly flushed, and have each of its openings into the house securely guarded from the entrance of air from the interior of the drain or pipe into the room. All drains, soil pipe, and waste pipe should be absolutely tight against the leakage of water or air.

The main line of the house drainage system begins at the sewer, flush tank, or septic tank, as the case may be, passes through the house by such a course as may be indicated by a judicious compromise between directness and convenience, past the location of the highest fixture that is to discharge into it, and then out through the roof for free ventilation. If possible, have the fixtures which are located on different floors in a direct line one above the other to avoid any considerable horizontal run. If bathrooms or water-closets are required in different parts of the house let each have its own vertical line of soil pipe. All plumbing fixtures on bedroom floors should be confined to bathrooms, and under no circumstances should there be a wash basin or any other opening into any channel which is connected with the drainage system in a sleeping room or in a closet opening into a sleeping room. Each bathroom should have exterior location and at least one window for light and ventilation, but pipes should not be placed against outer walls unless adequately protected against frost. Never have plumbing out of sight; let each pipe be in full view, and each closet, bath, or basin be unhidden by any sort of inclosing woodwork. There is quite as much danger from the dirt which is apt to gather around concealed pipes and beneath inclosed sinks, bowls, or closets as there is from the admission of sewer gas. The simplest way to prevent the accumulation of dirt is to make it easier to be clean than to be dirty. Therefore keep the plumbing fixtures where there is plenty of light.

Improvements for the Kitchen

The kitchen is a most important part of the house. On it depends the physical life, and to a large degree the spiritual life, of the family. Realizing its importance, sufficient time and thought should be given to it to secure the best results possible from the material at hand.

Ventilation, Walls and Floors

Perfect ventilation is the first requirement of a kitchen, light comes next, and in turn the possibilities of perfect cleanliness. The walls should be painted so that they may be wiped off with a damp cloth, making cleanliness possible without great demand on strength, and without the disarrangement caused by whitewashing and kalsomining. In these days of enameled paint the walls and shelves of all kitchen closets should be painted. Painted shelves can be wiped off with a damp cloth every day if need be. Paper in kitchen closets is always a bid for dust and vermin.

Hard wood makes the best kitchen floors. Linoleum or oilcloth are labor saving and, if cut to exactly fit the floor and all joints cemented, are perfectly sanitary. Intelligence does not countenance a carpet on the kitchen floor.

The Range

Whatever fuel is used, let the range be one of the best in the market. This is true economy. Near the range and under the same ventilating hood should stand the oil or gasoline stove. There is an infinite variety of these stoves, all economical, cleanly, and safe if managed with care.

A hood suspended over the kitchen range and connected to a flue in the chimney will gather all the steam and odors and carry them away.

Laundry Arrangements

When the kitchen is also used as the family laundry, stationary tubs of enameled iron or of soapstone should adjoin the sink. They should be covered to form a table when not in use, but as confined air near plumbing becomes dangerous the covers should close upon rubber knobs or wooden blocks, so as to leave an air space for ventilation. Nickel plated union strips and hardwood wringer holders should be added between the tubs and at the right hand end so that a wringer may be used. One of the needs of the ordinary farmhouse is a suitable place for the workmen to wash as they come from the fields. When a separate room is fitted up as a laundry, provision should be made here for the men by adding a large sink and bench.

The Kitchen Sink

The kitchen sink should be of cast iron, plain, galvanized or enameled, broad, and of a generous size, preferably with a high back to protect the wall from the water which is certain to splash when drawn rapidly from the pipes. The faucets should be set well up and back to avoid the breakage of dishes by striking them against the faucets. The waste pipe should be covered with a fairly fine brass strainer, which should be held securely in place by screws. At one end should be placed a long draining shelf, the shelf should be well grooved and inclined slightly toward the sink. Both tubs and sink should be well trapped, but as grease traps when neglected are filthy things, and as proper care of the pipes renders them unnecessary in an ordinary kitchen, they should be avoided. Kitchen and pantry sink drains should be treated frequently to a wash of hot water and ammonia or soda to keep them clear from deposits of grease. Kitchen sinks are used for the discharge of liquids which in their original condition are not offensive, but which after a little retention begin to putrefy, and it is very important to secure the complete removal of all such matter well beyond the limits of the house before putrefaction begins.

Refrigerator drains should never connect directly with the drainage system.

Hot Water Apparatus

A hot water supply may be furnished by a special heating apparatus in the cellar, a furnace connection, or, as is usual in small houses, by a boiler and water front attachment for the range. The cold water should always enter the boiler at some distance below the point of entrance of the hot water from the water front of the range; the greater this distance the better will be the circulation, and the less time it will take to heat a certain amount of water. The kitchen boiler is simply a storage tank to keep a supply of hot water on hand so that it can be drawn when required. The chemical properties of the water often determine whether a copper or galvanized iron boiler may be used. Certain waters will rust out a galvanized iron boiler in a few years, while a copper boiler, used in its place, would last a lifetime. The hot water stores itself in the upper part of the boiler and is forced out by the cold water entering at the bottom. The upper pipe, or hot water pipe, from the water front to the boiler must not be allowed to sag but must have as much elevation as possible, and also large sized elbows should be used, in order that the flow of water will have the least possible friction to contend with. The more elevation we get from the water front to the boiler the better the water will circulate, but the slightest rise in the pipe will make a satisfactory job. It should be a continuous rise from the range to the boiler. To prevent the pounding of steam in the boiler an expansion pipe should be provided to allow the escape of steam and air bubbles if the water comes from a tank in the attic. This expansion pipe should open over the overflow from the attic tank. When pressure tanks are used the expansion pipe must be omitted. The sediment which is constantly accumulating in the boiler should be blown off through the stopcock for that purpose, found under every boiler.

The range and boiler are set as close together as they can be for the purpose of getting the best results in regard to the heating of the water. The best kind of pipe for connecting them is either copper or brass, three-fourths or one inch in diameter, with fittings of the same material having threaded joints. Lead pipe is too soft for the purpose and will not stand the high temperatures which the water in these connections often reaches. If it is desired to draw hot water from the different faucets throughout the house at the moment the faucet is opened instead of having to wait until all the water in the pipe has been drawn out, it is necessary to have a circulation of the hot water at all times from the boiler to the different fixtures. The hot water pipe is started from the boiler and carried up, as shown in Fig. 2, to the highest fixture and then connected. The return pipe is carried down, as shown by the direction of the arrows, and this pipe connects with each of the lower fixtures, finally ending at the bottom connection of the boiler. Be sure to have some upward slope at all points to the pipe which leads from the boiler to the highest fixture; but it is not necessary that the return have a continuous fall.

Installation of the Bathroom Walls and Floors

The bathroom should be a light, well ventilated room with every facility for cleanliness. Floors and wainscoting of tile or composite material are most desirable, but painted walls are much less expensive and give excellent results. Tile is undoubtedly the most satisfactory material which can be used for the covering of the floors and walls where it can be afforded. Tile floor with covered base and walls finished with cement or hard plaster, painted with enamel paint, are much cheaper. When a tile floor can not be had, linoleum is an excellent substitute as it is practically impervious to water. It should be laid before the fixtures are set, in order that there may be no joints. Cement mixed with small chips of marble well rubbed down after setting makes an excellent floor, one that washes as clean as a porcelain plate and has no cracks to harbor dirt; the cost is only about twice that of a double wood floor, or 50 cents per square foot, including the necessary cement bed on which it is laid. When it is desired to lay a cement, composition, or tile floor upon floor joists, proceed as follows: Nail a 2 by 4 to the side of each of the floor joists flush with the bottom. Upon the top of these stretch wire lath, after the joists have first been covered with tarred paper to prevent them absorbing moisture; and upon this lay cinder concrete, made of one part Portland cement, three parts loose sand, six to eight parts crushed and screened furnace clinkers; filling in to a level at least two inches above the tops of the joists. Upon this is placed the floor finishing. Cinder concrete is used because it is so much lighter than that made of stone. When a tile or cement wainscot is too expensive the walls should be painted. Wall paper is not desirable in a bathroom, nor is wood paneling.

Bath Tub and Lavatory

A porcelain lined or enameled iron bath tub is the best medium priced tub. For supplying the tub with water a combination cock is best, allowing hot or cold water to enter the tub separately or the temperature to be regulated to suit the bather. The cock should be placed high, so as to allow of water being drawn into pitchers.

The best lavatories are those of porcelain or enameled iron, with back and overflow all formed as integral parts of the fixture. The basin cocks through which the hot and cold water come are of various shapes, the simplest being the best.

The Closet

The water closet is the most important plumbing fixture in the house, and should be selected and put up with particular care. A good closet should be simple, neat, and strong, of a smooth material, with ample water in the bowl. Among the modern closets there is none more satisfactory than the flushing-rim, siphon-jet closet, which can be had, including the trap, in a single piece of porcelain. Porcelain is used because no other material can be kept so clean and sanitary. But even this is an imperfect protection from dirt and disease unless the bowl is flushed so as to clean it completely and absolutely. The water should be poured from the rim of the bowl, so that every part of it is perfectly cleaned. The wash-down and wash-out closets are similar in make, but are not so thorough in their action. In the wash-out closet the basin acts as a receiver, a small quantity of water being retained in it, and into this the deposit is made, to be washed out afterwards into the trap by the flush. The water in the basin is prevented from leaking into the trap by a raised ridge which is apt to break the force of the flush so that its whole force is not directed into the trap, which is objectionable. The wash-down closet receives the deposit directly into the water held in the bowl by the trap. It has a straight back and a much smaller fouling surface. There is no open vent. The outlet is entirely covered with water, so that the water does not throw the soil against the side. The only advantage the siphon closet has over it is the greater force of discharge given by the siphon.

The siphon closet, like the wash down closet, retains a certain amount of water into which filth is discharged. In addition there is a siphon trap provided with a long ascending arm, so that the water in the trap is at a lower level than the water in the bowl. The water from the flushing cistern is directed not only into the bowl, but downward into the trap itself. As a result of this discharge into the trap a siphon action is produced whereby the contents of the bowl are sucked through the trap into the soil pipe without soiling the bowl. The seal—that is, the body of water which prevents the sewer gas from escaping into the house—is deep, broad, and always in plain sight.

Flushing Apparatus

The flushing cistern or tank for a water closet is always distinct from the main water supply. As a rule, a plain hardwood box, copper lined, is supported by brackets from the wall about 7 feet above and communicating with the closet by a pipe. This pipe is usually about 1½ inches in diameter and should have as few bends and angles about it as possible. The cistern should hold 2 or 3 gallons of water, all of which should be discharged at one time into the closet. The flush of the closet should be quick, powerful, and noiseless, thoroughly scouring all parts exposed to fouling.

The flow into the cistern is regulated by a float valve which allows the tank to fill, the float rising with the water; when it reaches the proper level the float is entirely raised and the supply shut off. When the tank is emptied by opening the flush valve, which is lifted by pulling a chain attached to it, the process is repeated. The cistern is usually provided with an overflow connected with the flush pipe, so that if the ballcock fails to act properly in shutting off the water the surplus will escape through the water closet to the drain instead of overflowing.

Soil-Pipe Connections

The best closets are provided with a brass screw soil-pipe connection, calked with lead and cemented into the base of the closet. The corresponding threaded brass coupling is soldered into the end of the lead bend which connects with the soil pipe. The closet is then screwed into the threaded coupling until the base rests on the floor. The closet may be removed at any time by simply unscrewing it. No bolts are necessary through the base flanges. In setting a water closet a neater finish can be obtained if a porcelain floor slab is put in with the finished floor.

General Suggestions

The important need of the work is simplicity, not only in detail, but in general scheme. Construct the water closet to be used as a urinal and slop sink and arrange to draw water through the bath cocks placed at the top of the tub. It not only saves cost, but is a great advantage to have the fewest possible points requiring inspection and care and to secure the most frequent possible use of every inlet into the drainage system. Great care must be taken not to throw into the water closet hair, matches, strips of cloth, or anything which is insoluble and liable to clog the trap and soil pipe. A burnt match seems small in itself, but if lodged in the trap it will collect other things and cause serious obstruction of the outlet. Tissue toilet paper should be used. Its cost would be exceeded many times if a part of the system needed to be taken out to free it from newspaper obstruction. It is often found more convenient to have the water closet with a separate entrance from the hall and entirely independent from the bathroom.

Traps and Vents

Every plumbing fixture must have a trap to prevent the foul air from coming back from the drain through the waste pipe. In its simplest form a trap is a downward bend in a pipe, so deep that the upper wall of the pipe dips into the water held in the bend, the extent to which it dips being known as the depth of the seal. With slight modifications this is the trap most commonly used for wash basins, laundry tubs, etc. Its greatest fault is the danger from siphonage; that is, the water seal may be carried out of the trap into the soil pipe by the rush of the water when the fitting itself is emptied, by the flow of water from another fixture on the same branch waste pipe, or by the discharge of water from a fixture higher up but connected to the same soil pipe. This danger is much lessened by the introduction of a system of ventilation pipes extending upward either from the trap itself or from the outlet near the trap. To avoid this extra expense of a third system of pipes, it is better to supply each fixture with one of the patent non-siphonage traps, which should also be self-cleansing. There are several good ones on the market. It is a good habit, after emptying the wash basin, bath tub, or kitchen sink, to allow some clean water from the faucet to run into the fixture in order to have clean water in the traps. All traps should be provided with trap screws, placed below the water line, and arranged so as to be accessible for cleaning.

Nothing short of continuous use will prevent the evaporation of the water in the traps. One with a large dip is best, but at the same time the trap must be so formed that at each use of the fixture all the filth that is delivered shall be carried away, the trap being immediately refilled with fresh water. Hair and fibers from cloth sometimes carry the water out of traps by capillary attraction, and care should be taken not to allow such things to enter the pipes.

The Soil Pipe

The soil pipe should extend from cellar to roof in a straight line, if possible, as each offset or bend forms an obstruction to its proper flushing with both water and air. Use only "extra heavy" soil pipe of uniform thickness throughout, as the hubs stand the calking better.

Avoid if possible plumbing fixtures in the cellar if the drain must go under the floor. If it is necessary to make connections with a fixture in the cellar it is better that the main channel should run under the floor to or near the location of such fixtures that all or nearly all of its length should constitute a part of the main drain thoroughly flushed and ventilated like the rest of the system. The pipe should be laid in an open trench and so thoroughly calked that under a pressure equal to one story in height not a drop of water should escape at any point, and then it should be inclosed in good concrete, after which the trench should be filled. The soil pipe should pass through the foundation by means of an arch, and the cast iron pipe should extend at least 5 feet outside the foundation; from there on, a carefully laid and rigidly inspected vitrified pipe drain is to be preferred. The joint between the iron pipe and the vitrified sewer pipe should be made with neat Portland cement mortar. If there are no fixtures in the cellar carry the drain in full sight along the face of the cellar wall, or suspended from the floor beams, so the joints may be inspected. At the point where it is to turn up as a vertical soil pipe support it by a post or a brick pier. Use no short turns in the soil pipe, like "tees" and "quarter bends." Two one-eighth bends or a Y branch and a single one-eighth bend give a more gradual and therefore a better change of direction. Water closets should connect to the soil pipe with a Y branch. The soil pipe should be secured along its entire length at distances not over 5 feet with hangers and clamps or hooks, so that it will be rigidly held in position. The joints in the cast iron soil pipe should be made by first inserting a little picked oakum into the socket, allowing none to enter the pipe; it is better formed into a sort of rope. The oakum prevents the lead from running into the pipe to form an obstruction to the flow. Enough molten lead is then poured into the hub to fill it. After the lead has cooled it is carefully hammered with a special calking tool until the space between the spigot and the hub is perfectly gas and water tight. Every joint should be made with a view to being tested with hydraulic pressure.

In making this test the simplest way is to close all openings into the pipe with wooden plugs or disks of india rubber compressed between two plates of iron forced together with a screw. There is no especial advantage in applying a great head of water, for if a joint is not tight it will leak under a head of a few inches. It is generally most convenient to test the vertical pipe story by story, the plugs being inserted through the water closet branches. There is probably no occasion to fear that work once made tight will develop leaks for many years, the tendency to rust after a time, even with tar-coated or enameled pipe, being rather to close such slight leaks as may exist.

Four inches in diameter is sufficient for soil pipe, and the best results are obtained by running it full size straight above the roof and covering the top with a wire basket such as is used to keep leaves out of gutters.

There should always be a trap between the house and the sewage disposal plant, and there must also be on the house side of it an inlet for fresh air. There can be no real ventilation of the system if it is open only at the top, but a generous inlet for fresh air on the drain outside the house, in connection with the opening at the top of the soil pipe, will insure a free movement throughout the whole system. The fresh air inlet must be guarded from obstruction. It may be brought out close to the foundation walls, but not too near windows and doors. If the trap is formed by the submerging of the inlet pipe in the settling chamber of the disposal system the fresh air inlet should be placed close to this.

The Waste Pipes

For all minor waste pipes lead pipe is used, as it may be bent and cut to suit all possible positions and requires but few joints. Only "heavy" lead pipe should be used. As lead is quite a soft material it would not be practicable to use thread joints on it, so the joints are made by the use of solder. Where lead pipe joins to cast iron pipe the connection should be made by means of a brass ferrule of the same bore as the lead pipe, and soldered to it. The ferrule is introduced into the hub of the cast iron pipe and calked tight with oakum and lead.

Heating Systems

The Ideal System

The health and comfort of the home depends to a considerable extent upon the heating apparatus, which, in importance, is second only to that of sanitary plumbing. Stoves are a development of the fireplaces of our ancestors. Their waste of fuel, their uncleanliness, and their inability to properly heat even one room are features recognized by most people. The ideal heating apparatus is one that will promptly and continuously supply every room in the house with enough warm fresh air to make it comfortable in the coldest weather. It must be easy to manage and not complicated in construction. The cost of installing a steam or hot water system is more than that of a hot air furnace. The amount of fuel used by them is less, but for a small house the hot air furnace is most often used. It has the advantage, too, if properly installed, of supplying fresh air, while the other systems demand special means for ventilation, or dependence must be placed entirely upon opening the doors and windows.

Furnaces

A furnace is a stove within a casing of galvanized iron or brick. Air is admitted to the space between the two and when it becomes heated passes through pipes to the different rooms of the house. The furnace may be constructed of cast iron, wrought iron, or steel. The cast iron furnace has fewer joints than the one made of steel plates and will not vary in temperature so rapidly.

Direct and Indirect Draft

In construction there are two styles, the "direct" and the "indirect" draft. The better class of the "direct" draft furnaces have a radiator through which the hot gases pass on their way to the smokestack, and so utilize much heat that would otherwise be lost. In the "indirect" draft furnaces the gases pass through radiators at the bottom and from there to the smokestack. A direct passage is furnished to be used when the fire is being started or when coal is being added. Some furnaces are "built to sell" by their size and are not furnished with a radiator. These will burn more fuel and give off less heat.

The Smoke Pipe

The smoke pipe should connect to the chimney as directly as possible, for elbows diminish the draft. The flue should be at least 8 inches by 12 inches and should have no other opening into it for range or fireplace. A clean-out door should be provided at the bottom, fitted with a tight door, and this door must be kept shut, except when cleaning out the flue.

The Grate

The grate is one of the most important parts of a furnace, and there are many kinds to be had. The essential things are the removal of the ashes and cinders from the entire grate surface without carrying unburned coal with them, and the admission of air to secure proper combustion of the fuel. In comparing furnaces the average diameter of the fire pot is taken. The space above must be large enough to permit of the thorough mixing of the gases with air or else much heat will be lost by imperfect combustion. If soft coal is to be burned a larger combustion chamber is needed than with hard coal, as the supply of air must be greater.

Furnaces differ in the manner of bringing the air to be warmed into contact with the surfaces heated by the combustion of the fuel. The area of the heating surfaces should be about 60 times the area of the grate surface to prevent overheating of the air in cold weather.

Where natural gas is available the furnace can be arranged to burn it, but it is well to have a coal grate also in case the gas should be shut off. Wood furnaces are generally more simple in construction and are often built to take a 4-foot stick. Where wood is cheap excellent results may be obtained. The smoke should pass through a radiator, as in case of coal furnaces.

Distribution of Hot Air by Means of Pipes

Much depends upon the location of the furnace. It should be placed somewhat to the north and west of the center of the house—that is, toward the prevailing cold winds. As the hot air travels best through the pipes leading toward the sheltered part of the house and to the upper rooms, the pipes leading toward the north and west or to the rooms on the first floor should be given the preference with respect to length and size. Make all pipes as nearly the same length as possible and as short as the location of the registers will permit. Long horizontal runs of pipe should be avoided, especially in first floor pipes. The pipes should pitch upward as sharply as possible so the resistance will be less. Each pipe should have a damper near the furnace. Each room should have a separate pipe, if possible, or the heat will go to the less exposed room when a wind is blowing. Exposed pipes should be provided with an asbestos covering, even when made double; double pipes are the best for all work. Bright tin is almost always used for hot air pipes, as it radiates less heat than any other suitable material. The registers should be as near the furnace as possible. Nothing is gained by putting them on the exposed side of the room and much heat is lost. First floor registers may be placed in the floor if wall registers would interfere with the pipes to the second floor. Second floor registers should be placed in the wall so as to avoid the necessity of cutting carpets and not to furnish receptacles for dirt. If only the first floor is heated the registers should be placed in the wall. The net area of the register should be about 15 per cent greater than the section of its hot air pipe.

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Fermentation and Ferments

No. 1—Insoluble Ferments

Fermentation is a chemical change produced by a class of bodies called ferments. Insoluble or organized ferments are single celled, microscopic plants which have a definite structure. Nearly all of them secrete definite chemical products capable of producing fermentation. The insoluble, or organized ferments, are composed mainly of nitrogenous compounds, but also contain non-nitrogenous and mineral matter. Some, as the tubercular organism, contain cellulose.

No. 2—Soluble Ferments or Enzymes

Enzymes are organic compounds, secreted by cells, and have the property of producing chemical changes. They are also called soluble ferments, chemical ferments, and diastases. Diastase is a white amorphous compound, converting starch by fermentation into dextrine and sugar. It is found in the sap of plants, and in animal saliva. There are a great many kinds of soluble ferments, some of which as diastase are capable of acting upon carbo-hydrates, while others, as pepsin and pancretin, act upon proteid bodies. Enzymes produce chemical change, without entering into the composition of the substance or giving up any of their material to the reacting compounds. A small amount of diastase will change a large amount of starch to soluble forms, without losing its power of action. The enzymes are all soluble in water and are precipitated with strong alcohol. Their action is not generally retarded by antiseptics and chemicals which are capable of destroying the organized ferments. When seeds are soaked in water, the diastase and proteose enzymes are extracted and if precipitated in alcohol and recovered they appear as a light gray powder. An organized ferment is a low form of plant, while a soluble ferment is a chemical compound.

No. 3—Aerobic and Anerobic Ferments

Ferments that require oxygen for their existence are aerobic while those capable of working in the absence of oxygen are anerobic. The aerobic ferments produce carbon dioxide, water, ammonia and hydrogen sulfid as final products while anerobic ferments usually produce intermediate products as organic acids.

No. 4—Conditions Necessary to Fermentation

The conditions necessary to fermentation are:

(1) Moisture. (2) Favorable temperature. (3) A ferment body. (4) A fermentable substance.

Moisture is necessary in order that chemical changes may take place. During fermentation water enters often into the chemical reaction, as in hydration changes, and is also necessary as a medium of exchange for the chemical products of the reaction.

The most favorable temperatures for the fermentation are between 15 and 60 degrees Centigrade. Below zero and above the boiling point of water, ferments are inactive. Some ferments require a different temperature for activity from any others.

A ferment body is always necessary to start the fermentation change, and in the absence of a ferment, either organized or unorganized, no ferment can take place.

A fermentable substance, with the right kind of ferment to act upon it, is also requisite, as a ferment which acts upon one class of bodies is incapable of changing starch to soluble forms. When a substance is freed from all ferments and is protected from all sources of outside contamination, it is in a sterile condition. Many forms of fermentation are produced by the spores of organized ferments gaining access to a material along with dust particles carried in the air. In the preservation of food, a knowledge of the conditions necessary for fermentation is made use of. The products formed by ferments are numerous, as are ferment bodies capable of acting upon all forms of organic matter. Some of the ferments assist in the digestion of food and in the preparation of food products, while others take an important part in every-day life affairs, and in agriculture in the liberation of plant food. The growth of plants, the preparation of foods, their digestion and the manufacture of food products all depend largely upon fermentation.

f plants, ferments play rt, both in the prepara- food and in the chemical at take place in the plant. *ation of the mineral food of the assisted by ferment action.* The rogenous food of the plant is all prepared in the soil by ferment action.

Aceteus or Acetic Fermentation

A form of oxidation in which alcohol is converted into vinegar or acetic acid by the agency of a specific fungus or ferment called "*Mycoderma aceti.*" The process involves two distinct reactions in which the oxygen of the air is essential. An intermediate product called "aldehyde" is formed in the first process.

$$1\ C_2H_6O + O = H_2O + C_2H_4O.$$

$$2\ C_2H_4O + O = C_2H_4O_2.$$

Alcoholic Fermentation

The fermentation which saccharine bodies undergo when brought into contact with the yeast plant or torulae. The sugar is converted either directly or indirectly into alcohol and carbonic acid, the rate of action being dependent on the rapidity with which the torulae develop.

Ammoniacal Fermentation

The conversion of the urea of urine into ammonium carbonate, through the growth of the special urea ferment. Whenever urine is exposed to the air for several days in open vessels, it undergoes this alkaline fermentation.

Butyric Fermentation

The fermentation of various forms of organic matter through the agency of a peculiar worm shaped vibrio, with the formation of more or less butyric acid. It is one of the many forms of fermentation, that collectively constitute putrefaction.

Enzymatic Ferment

This has already been described.

The Fermentation Theory of Disease

The theory that most, if not all, infectious or zymotic diseases are caused by the introduction into the organism of the living germs of ferments, or ferment bodies, already developed, (organized ferments) by which, processes of fermentation are set up injurious to health. This is akin to the germ theory of disease.

Glycerine Ferment

The fermentation which occurs on the mixing of a dilute solution of glycerine with a peculiar species of schizomycetes and some carbonate of lime and other matter favorable to the growth of the plant, the glycerine being changed into butyric acid, butyl and ethel alcohol. With another form of bacterium (*Bacillus subtilis*) ethel alcohol and butyric acid are mainly formed.

Lactic Fermentation

The transformation of milk sugar or other saccharine body into lactic acid, as the souring of milk, through the agency of a special bacterium (*Bacterium lactis* of Lister). In this change the milk sugar, before assuming the form of lactic acid, presumably passes through the stage of glucose.

FERTILIZATION. See *Apple Orchard.*

FERTILIZER, COMMERCIAL. See *Apple Orchard Cover Crop.*

Fertilizing Value of Rain and Snow

Experiments have been conducted during the past few years at the Canadian Experiment farms by F. T. Shutt, relating to the fertilizing value of rain and snow. The report for 1911 shows that during the year the precipitation amounted to 26.97 inches, the total nitrogen per acre brought down by rain and snow was 5.27 pounds, about 84 per cent being furnished by the rain and 16 per cent by snow. Of the total nitrogen 3.73 pounds was in the form of free and albuminoid ammonia and 1.54 pounds nitrates and nitrites.

E. S. R.

Figs

The fig is the fruit of any one of the various species of the cultivated varieties of *Ficus carica*. Fig trees vary greatly in habit, some of them being low trailing shrubs, others gigantic trees. They have alternate leaves, which abound in a milky juice, usually acrid, though in a few instances sufficiently mild to be used in allaying thirst. The figs of commerce are grown on a small tree or shrub, rarely more than 20 feet in height.

The fig seems to be indigenous to Syria and Asia Minor, but for a long period of time has been grown in the countries around the Mediterranean sea and judging from passages in the writings of Herodotus, and from the Hebrew scriptures, it was an article of food and commerce, centuries before the Christian era.

In the warm countries, the tree generally bears two crops in one year, the first in the early summer from the buds of the previous year, the other in the autumn from the buds of the spring growth.

Fertilization

The question of the fertilization of figs was early little understood. It was believed that the flowers were unisexual and therefore from very ancient times it was the habit of certain growers to place branches of the wild fig in flower over the cultivated varieties, in order that the pollen from the wild flower might fertilize the female flowers of the other. From the Louisiana Experiment Station, we quote the following on the subject of fertilization:

Southern figs produce *pistillate* or *female* flowers and *mule* or *sterile* flowers. While they do not produce *staminate* or *male* flowers, nevertheless, they possess the ability to develop an edible product, with no true seed. It is impossible for any of our figs to produce true viable seed, hence unless figs of another class capable of producing seed are grown in Louisiana, one may never expect a variety of figs of Louisiana origin. The different blooming habits of our figs easily separate them into three distinct divisions.

Class 1—*Mission Figs*, capable of producing both an early and a late crop.

Class 2—*Adriatic Figs*, capable of producing a late crop, but dropping all of its first crop.

Class 3—*San Pedro Figs*, capable of producing an early crop, but dropping all of its late crop.

The *sterile* or *mule* flowers are the ones that develop into our edible fig. The *pistillate* or *female* flowers invariably drop off.

In the Mission class of figs the *sterile* or *mule* blooms predominate in both its *early* and *late* crops, hence, climatic conditions being favorable, two crops of figs may be obtained.

In the *Adriatic Figs* the *pistillate* or *female* blooms predominate in the *early* crop, and the *sterile* or *mule* blooms predominate in the *late* crop, hence the *early* crop drops, and the *late* crop matures.

In the San Pedro Figs, the *sterile* or *mule* blooms predominate in the *early* crop, and the *pistillate* or *female* blooms predominate in the *late* crop, hence the *early* crop matures and the *late* crop drops.

Occasionally *sterile* or *mule* blooms on both the early crop of the Adriatic type of figs and the late crop of the San Pedro type of figs may develop into edible fruit.

GRANVILLE LOWTHER

Propagation

The fig is easily propagated by cuttings, layering, ring-budding, and grafting. Propagation by cuttings is the easiest and most satisfactory way. The work can be done at almost any time of the year; but by far the best results are obtained if done during the winter while the plant is dormant.

The cuttings should be taken from strong, healthy plants of the desired variety and preferably from plants growing in the immediate locality. Select the one-year-old branches that are plump and stocky, which are usually found on the outside, where they were well exposed to the light. Do not take the long, slender shoots or suckers found on the base of the plant.

A good cutting should be at least one foot long, or preferably longer. The cut ends should not expose any pith, but the hard wood of the partition found at the node. The cuttings should not be allowed to dry out, or become shriveled; as soon as made they should be tied into bundles of convenient size and buried in moist sand. The following spring they should be planted either in the field where they are to remain permanently or in the nursery row. The latter method is usually preferable, as they can be given better care and grown at less expense. They should be planted deep, leaving only the uppermost bud just above the surface of the soil. Some prefer to make the cuttings late in the spring and plant them at once in the field. This is certainly the most economical method.

Planting

The soil should be thoroughly prepared by deep plowing and enough disking and harrowing to pulverize every clod. Usually clay soils are not plowed deep enough, especially by the beginner. It must be remembered that the fig is naturally a very shallow-rooted plant, especially where the subsoil is hard and comes up near the surface. Clay soil should be plowed eight to ten inches deep and then subsoiled to a depth of six to eight inches. This gives opportunity for proper root development, and storage of large quantities of water.

The best time to do the planting is in the spring. Fall planting is not advisable, as the young plant can not endure very much cold until it becomes well established. If the planting is done in the fall or winter the young plant should be entirely covered with dirt until spring.

The distance apart to plant will depend on the variety and the method of training, whether in tree or bush form. Such semi-dwarf varieties as Brown Turkey are usually planted 10x10 or 12x12 feet apart in this state. Large growing varieties, like Celestial, need more room—15x15 to 20x20 feet.

For best results the fig should be planted deep. The young plant should be planted from four to six inches deeper than it stood in the nursery row; and then the entire top of the plant should be cut off at the surface of the ground. This induces a number of branches to come out from below the ground, which give the clump or bush form so desirable in the Upper South. If the cuttings are planted in the permanent places in the field the plants should be cut down to the ground one year after planting. Some growers put from three to five plants or cuttings at each place instead of one, with excellent results.

F. C. Reimer,

Horticulturist, North Carolina Agricultural Experiment Station, West Raleigh, N. C. Bulletin 208.

Pruning

As the Magnolia fig bears only on late wood of the previous year's growth or new wood of the current year's growth, the object is to produce as much new wood as possible—as in growing grapes.

Standard Heads

First Year

Allow three to five limbs to start close to the top so located as to make a well balanced head, and rub off all other limbs and remove all suckers that may start from the base of the tree.

Second Year

Cut previous year's growth back to within 12 inches of main stem. When growth starts allow each of the stubs to throw out two or three limbs, keeping all others off.

Third Year

Cut previous year's growth same as second year, and allow them in turn to produce two or three limbs each.

Tools

For cutting back, small and large pruning shears should be used; for removing suckers from the root use a carpenter's gouge chisel.

Soils

The fig will grow on most soils, but commercial plantings should be confined to heavy black land and black sandy land, and it must be underlaid with porous clay subsoil not more than two feet below the surface. The reason for this selection of soil is that the only dangerous disease attacking the fig is what is commonly known as Knot Root (*Nematode*), and this seldom does injury in heavy black soil. The reason for this, I believe, is that the heavier the land is the less oxygen there is available, and the parasite cannot exist without a certain amount of this element.

R. H. Bushway,
Algoa, Texas.

Districts Where Grown

Figs are grown in hot houses, or in specially protected places, in the Northern or Middle states, or they are sometimes grown in very limited quantities by specially protecting the tree from the freezing of winter. But the districts where it can be grown in commercial quantities, according to the recommendations of the American Pomological Society are as follows:

District No. 4—Turkey Brown.

District No. 5—Angelique.

District No. 6—Angelique, Brunswick, Celesta, Genoa, Turkey Brown, Marseillaise, Mission, Monaco, Bianco, Osborn Prolific, Reine Blanche.

District No. 7—Celesta, Turkey Brown, Mission, Monaco, Bianco, Osborn Prolific, Reine Blanche.

District No. 16—Mission.

District No. 17—Mission.

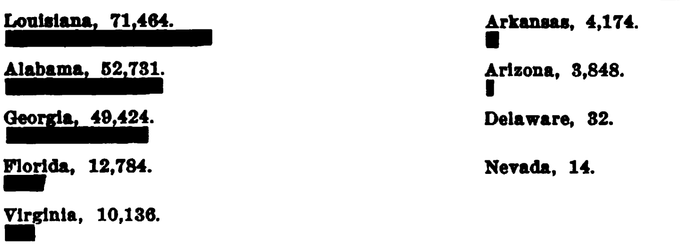
For description of districts see page 192.

For further information and for profits from FIG CULTURE, see *Alabama.*

Figs in the United States

There are but few states in the Union which produce figs for commercial purposes. The following are reported in the census of 1910 and the number of bearing trees produced by each state appended:

(Scale, 5 cm per 100,000.)



Floriculture

JOHN W. DUNCAN.

Spring Flowering Bulbs

In the early days of spring the first flowers to appear are such as the snowdrop, the crocus or the scilla, to be followed a little later by the tulip, the hyacinth and the many varieties of narcissi, see Fig. 1. In order to have a good showing of these flowers, they should be planted during the fall months of October and November. This gives the bulbs a chance to form roots so that they have a stronger start in the spring. When beds are to be solidly planted with these bulbs, the soil should be well prepared and a rich sandy loam is undoubtedly preferable.

It is very essential that the beds should have perfect drainage so that there is no danger of water standing on the ground during the winter, which has a tendency to rot or weaken the bulbs. The soil should, if not naturally sandy, get a good coating of sand mixed into it and should be dug to a depth of at least 15 inches. Well rotted cow manure is perhaps the best fertilizer that can be used, but fine ground bone will also be beneficial. The beds are better to be raised a few inches higher than the surrounding ground, to effect a more perfect drainage.

In planting bulbs, many people put a small quantity of sand around each bulb, or often the top soil is taken entirely off the bed to the depth at which the bulbs are to be planted, a coating of sand then spread over the bed, the bulbs then set the proper distance apart and the top soil carefully replaced. Where the bed has been prepared as mentioned in the first place, this plan need not be

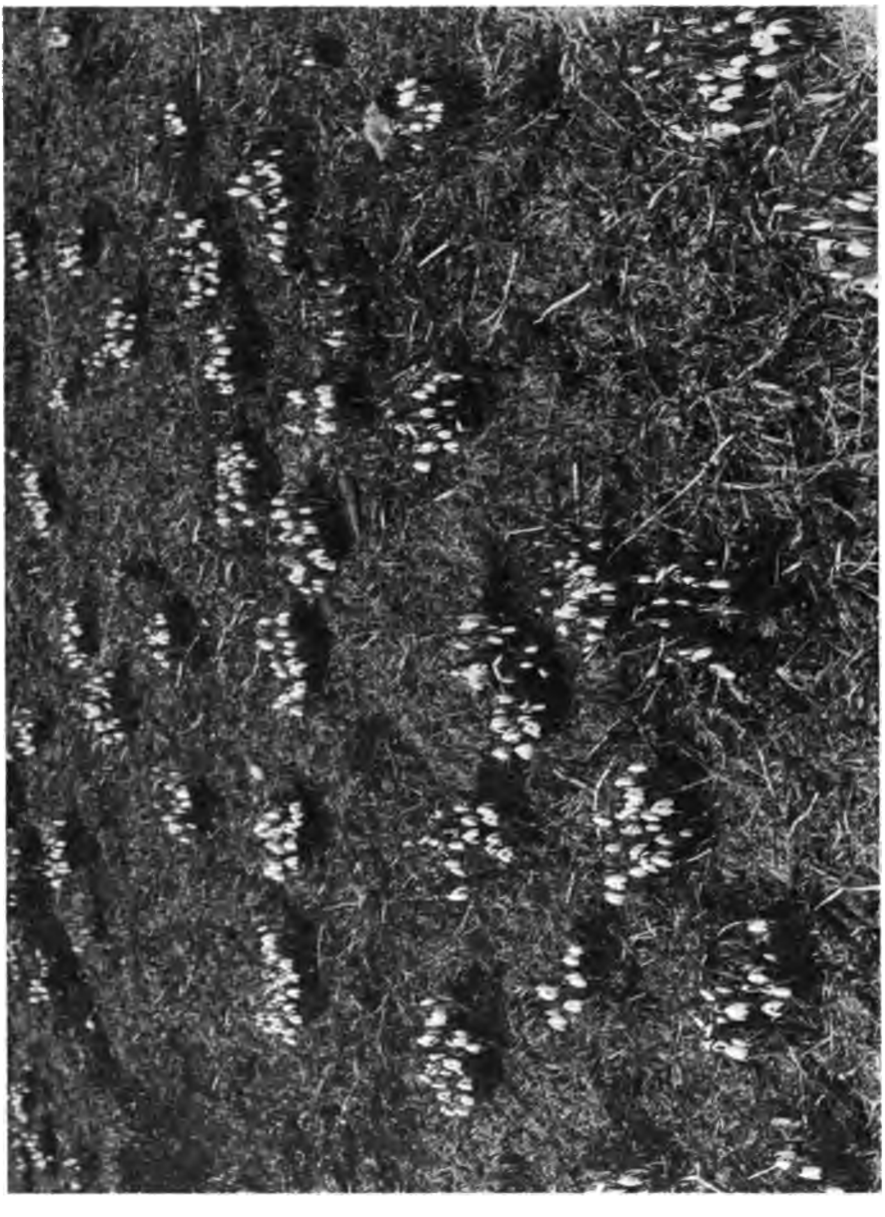


Fig. 1. Snowdrops in Grass

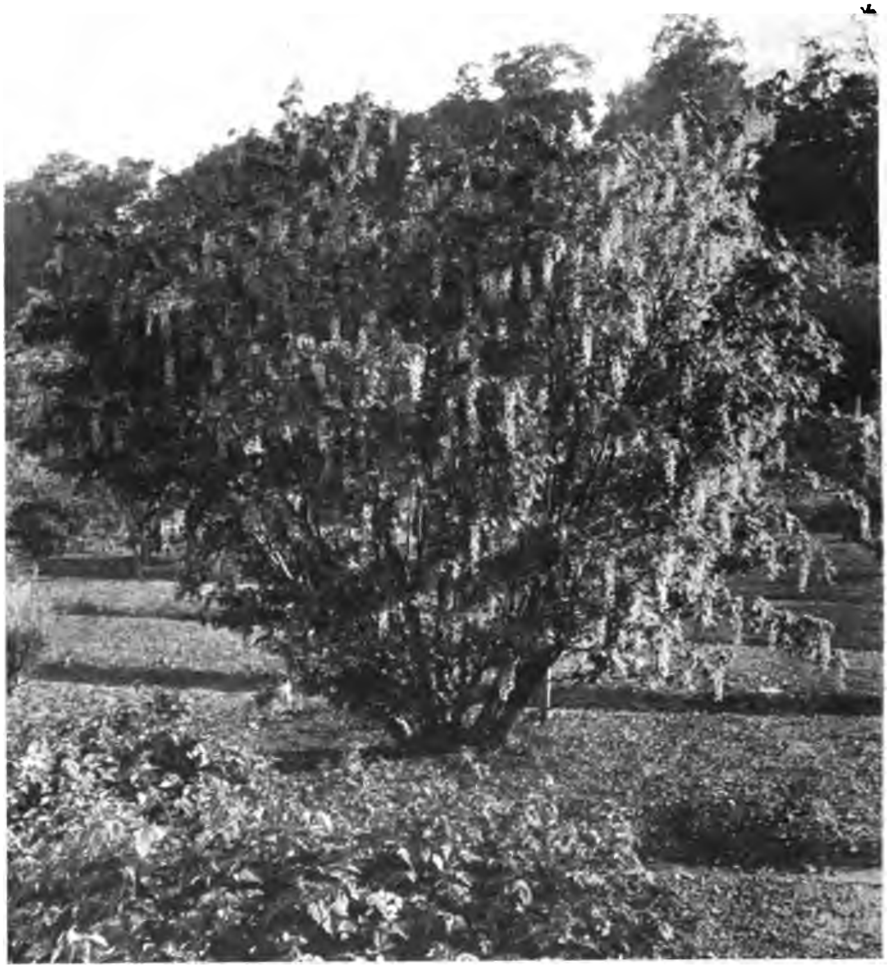


Fig. 2. Golden Chain (*Labrum alpinum*)

adopted as the bulbs may be more readily planted with a trowel. The depth at which each bulb should be planted depends mainly on variety but care should be taken that each bulb in a bed should be planted at the same depth, so as to insure blossoming at the same time. From four to five inches is deep enough for tulip bulbs and five or six for hyacinths, while small bulbs like the crocus and scilla, etc., three to four inches is sufficient, but better results will follow from a little too deep planting than from too shallow. Larger bulbs like lilies should be planted to a depth of from eight to twelve inches. If in a section of country where the ground freezes during winter, a coating or mulch of coarse litter or leaves should be put on the beds to protect the bulbs from too severe freezing and the changes from freezing and thawing of the ground. This mulching should be removed as early as possible in the spring. In many instances it is necessary to lift the bulbs so that something else may be planted in the beds. This may be done before the plants are thoroughly ripened by lifting with a little dirt along with each bulb which may be placed in a row somewhere else until ripened, when they may be laid past for another season's planting.

In the hardy border, bulbs may be planted in patches among herbaceous plants. They will not only do well and make the border look showy in the earliest days of spring, but have a good chance of ripening there and need not be disturbed from year to year. Where bulbs are grown this way, annuals may be planted to take their places through the later summer months. Some of the varieties of bulbs, like the crocus, snowdrop and the scilla, may be effectually planted in the lawn and make a good showing in the early spring immediately after winter is past.

In semi-wild gardens these bulbs are very effective planted along with such plants as the erythoniums, bleeding hearts, etc. When this is done, each variety or color should be in as large a patch as possible. Nature always plants this way.

Lawns

The importance of a good lawn is one of the principal features of ornamental gardening. Contrary to the expectations of many, a first-class lawn cannot be obtained unless there is sufficient depth of soil and the same has received the proper preparation. It should always be borne in mind that grasses are deep-rooted plants and if a fine velvety luxuriance is to be had, the soil must be from 12 to 18 inches deep. In many places we see only a few inches of soil spread on the top of a poor sub-soil, or gravel, or even often on a ledge of rock and a lawn started and kept green on the same by means of copious and almost continuous watering. In no instances of this kind, however, can a good lawn be expected. That fine velvety touch of the good lawn is found only where consideration has been given to the various grasses of which the lawn is composed.

Any good soil is suitable for a lawn. It will, however, need some attention to prepare it for the proper plant food. If it is sandy or gravelly, attention should be given to the addition of humus. If, on the other hand, the soil is clayey, or should contain signs of alkali, attention should be given to counteract these and bring into the soil more of the plant foods required by the grasses. For the counteraction of alkali in soils abundant quantities of manure should be plowed into the soil and turned up to the storms of winter.

In preparing the soil for seeding, it should be deeply plowed, well drained and properly graded and finished to an even surface with an iron rake. In seeding a small lawn the sowing may be done by hand but care should be taken to scatter the seed evenly. On a large lawn a hand or power seeding machine may be used, and in many cases it is desirable to use various grasses on a lawn; in fact, it is always advisable to use several species. The reason for this is that some grasses will thrive better in some soils than others, and by using a combination

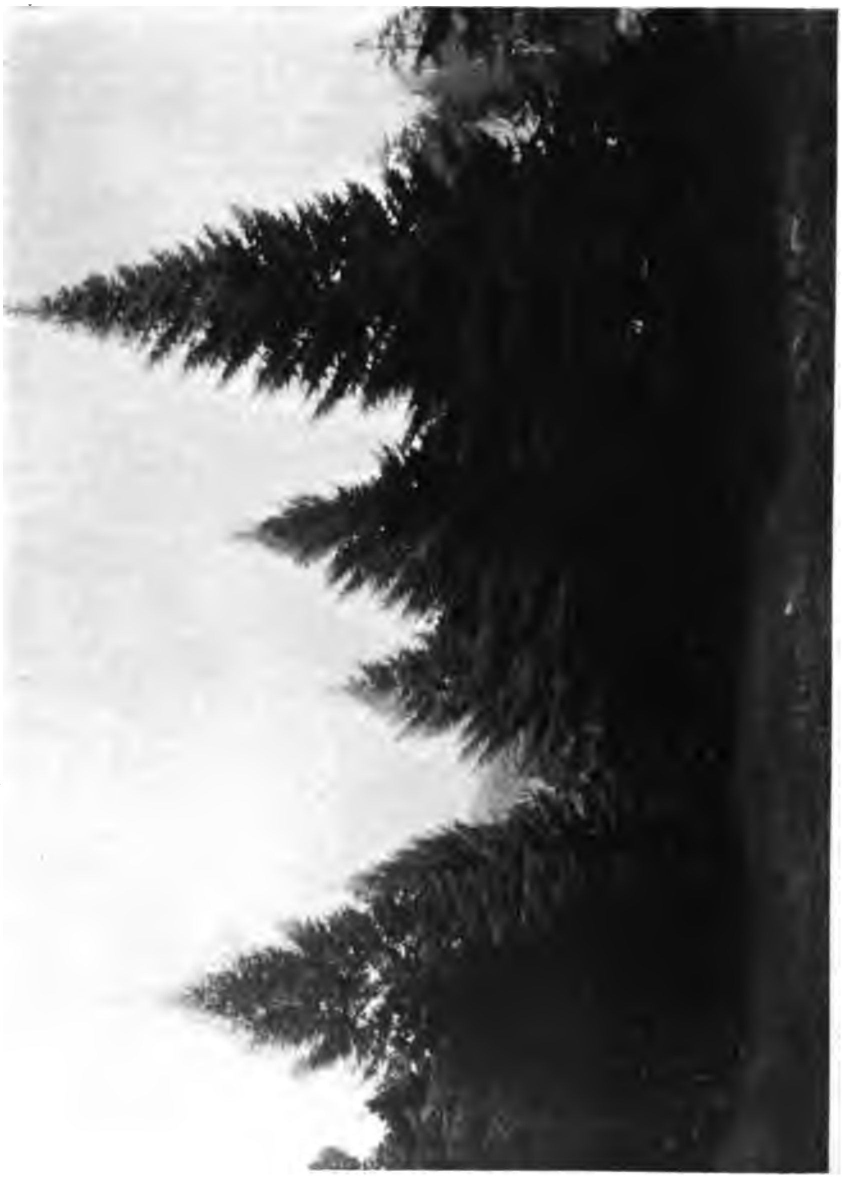


Fig. 3. Engleman's Spruce (*Picea englemani*)

experience has shown that a better lawn will always be obtained. A good lawn mixture is a combination of Kentucky Blue Grass, Fancy Red Top and Creeping Bent in equal parts with, if desired, a proportion of ten per cent (10%) White Clover.

In sections where the winter is not severe, the seeding may be done in the spring or early fall, while in some of the mountainous sections, early summer will be more satisfactory for the starting of the young grasses. Where summer seeding is done, proper care must be given to the watering and it has been found of great advantage to cover over the ground with a light mulch of well rotted manure. This prevents the hot sun from burning the young rootlets of the small grass plants and also helps to hold moisture after watering. The proper care of lawns after they are established consists of cutting the grass at the right time, sufficient watering and the keeping free of obnoxious weeds. The latter can be done only by persistent work from the start in taking them out by the roots. Occasional rolling is beneficial in that it keeps the soil of an even nature. Mowing should not be done as often as sometimes seen; in fact, most people are apt to cut the grass too closely, thus preventing the lawn having that velvety texture so much desired. Good judgment is also required in watering and it is much better to give a good watering and then let the lawn remain until such time as it may actually need watering rather than to sprinkle too often.

In the autumn the grass should not be cut too short for during the winter months, at mild intervals, weeds will start in and get ahead of the grass which has been weakened by its continuous cropping and therefore cannot cope with its more sturdy neighbor, the weed.

Many different fertilizers are used; perhaps one of the most satisfactory is fine ground bone applied in liberal quantities at various seasons of the year. Sheep manure is also one of the best natural fertilizers that may be applied towards the end of winter.

Ornamental Trees

For the decoration of grounds, both public and private, there are many varieties of ornamental trees both deciduous and evergreen that may be used and where the grounds are of sufficient size to warrant the grouping of different species to give the most picturesque effect much studying is required.

In the planting of parks or parking, the main thought should always be the appearance of the picture when completed and the size and shape of the tree, the foliage effects both summer and fall and harmony with its neighbor, all require forethought.

In general street planting, much more care is necessary than is generally seen in the preparing of the parkings for the trees. When new streets are being laid out, little or no attention is paid to the planting space. The street parking should have sufficient quantity of good loam for the development of whatever variety of tree is planted. Well shaped nursery grown trees should be selected and planted at a distance of from 30 to 60 feet apart, according to the variety. It is often the custom to cut off the entire top of the tree when planting. This is the greatest mistake ever made by the planter. A tree should be pruned when planted, but the proper pruning is only a thinning out or shaping back of side branches, leaving a straight leader in the center of the tree. When the tree is being dug for planting, it is absolutely necessary to save all of the fibrous roots possible and any of the large roots which may have been mutilated should be pruned back, so that a new growth will start. The most important of all when digging trees out is an immediate covering of the roots from the weather, to prevent drying up. More trees die from lack of this precaution than from any other cause. The drying winds and hot suns, so prevalent in many sections of the country, soon take the vitality out of the fibrous roots and the tree is unable to cope with the transplanting.

In planting a street tree, see that a large enough hole is dug to give the tree

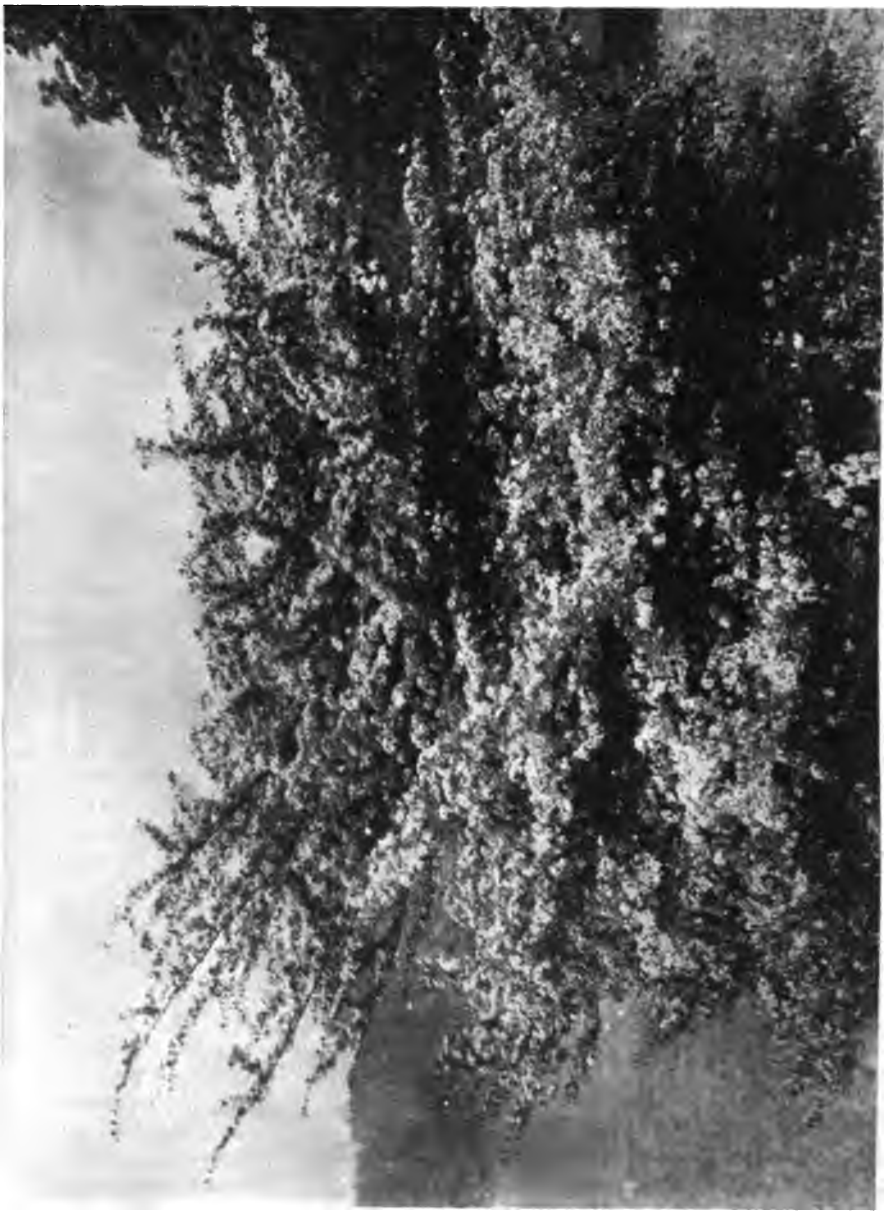


Fig. 4. Cockspur Thorn (*Crataegus Crus galli*)

plenty of nourishment for growth in years to come. Ordinarily, holes five to six feet in diameter by three feet deep should be made for street trees, and good loam used for the entire planting. In planting, place the loose loam in the bottom of the hole, treading it firm and raising it so that it will be higher than the center and the proper height to have the roots of the tree not too deep. This will have to be done in accordance with the quantity of roots the tree has and, as a safe guide, a mark where the soil before touched the stem will be seen, and this should be taken as the place that should again touch the surface of the ground. In no case should the ground slope away from the tree when planting is finished. On the other hand, it is better that the ground should slope toward the tree. In filling in the hole, only fine loam should be put nearest the roots of the tree and as it is thrown in should remain firm, being tamped with a round tamper about the size of a pick handle, so as to make the soil firm over and through the roots. Make the soil firm among the roots and do not be afraid to thoroughly tamp.

Trees should be planted, in many locations, in the early spring and before the buds start into a new growth. On the other hand, fall planting will be found more advantageous to many of the varieties.

Much might be said regarding varieties and it is often a hard matter to settle which variety is the most suitable for a certain location. Some of the best varieties of trees for street planting are the
Platanus Orientalis (Oriental Plane tree)
Acer, Platanoides (Norway Maple)
Acer, Pseuda Platanus (Sycamore Maple)
Acer, Saccharinum (Sugar Maple)
Aesculus hippocastanum (Horse chestnut)
Catalpa Speciosa (Western Catalpa)
Quercus Rubra (Red Oak)
Quercus Palustris (Pin Oak)
Sorbus Aucuparia (European Mountain Ash)
Tilia Europea (European Linden)
Tilia Platyphillos (Broad-leafed European Linden)
Tilia Dasytyla (Crimean Linden)
Ulmus Americana (American White Elm)
Ulmus Campestris (English Elm)

Roses

In the planting of roses the selection of a good location is the first essential and it is better to keep them from shade and away from the roots of trees. Roses will thrive in any good soil. It has often been said that roses require a clayey soil. This has been proven however to be incorrect, as many of the best rose plants will be found growing in the gravelly and fine sandy soil. The soil however must be well enriched with plenty of decomposed stable manure, cow manure being preferable. The ground should have good drainage and should be loosened up to a depth of from 1½ to 2 feet.

Roses may be planted in the fall or before the ground freezes, or in the early spring before the growing season starts in. Care should be taken to spread the roots of the plants out evenly and the soil should be drawn firmly through the roots of the plant. When budded or grafted plants are used they should be planted at from three to four inches below the bud or graft, that is, where the rose is united to the stock. This is beneficial, as by so doing new roots are pressed from the base of the rose plant, thereby giving it increased strength and helping to prevent the growing of suckers from the briar on which the roses budded are grafted. The distance for planting may be varied according to the varieties planted, 18 to 24 inches being about the general distance for most varieties.

In some sections mulching will have to be done in the winter, to prevent the ground from heavy freezing and help protect the plants. This means the covering of the ground with five or six inches of coarse litter. Pruning should be done in early spring before the growth is started in the plants. Cut out as much as possible of the old wood; that is, wood that has flowered last year, leaving the strong shoots of last year's growth which should be cut back to from eight to 12 inches from the ground.

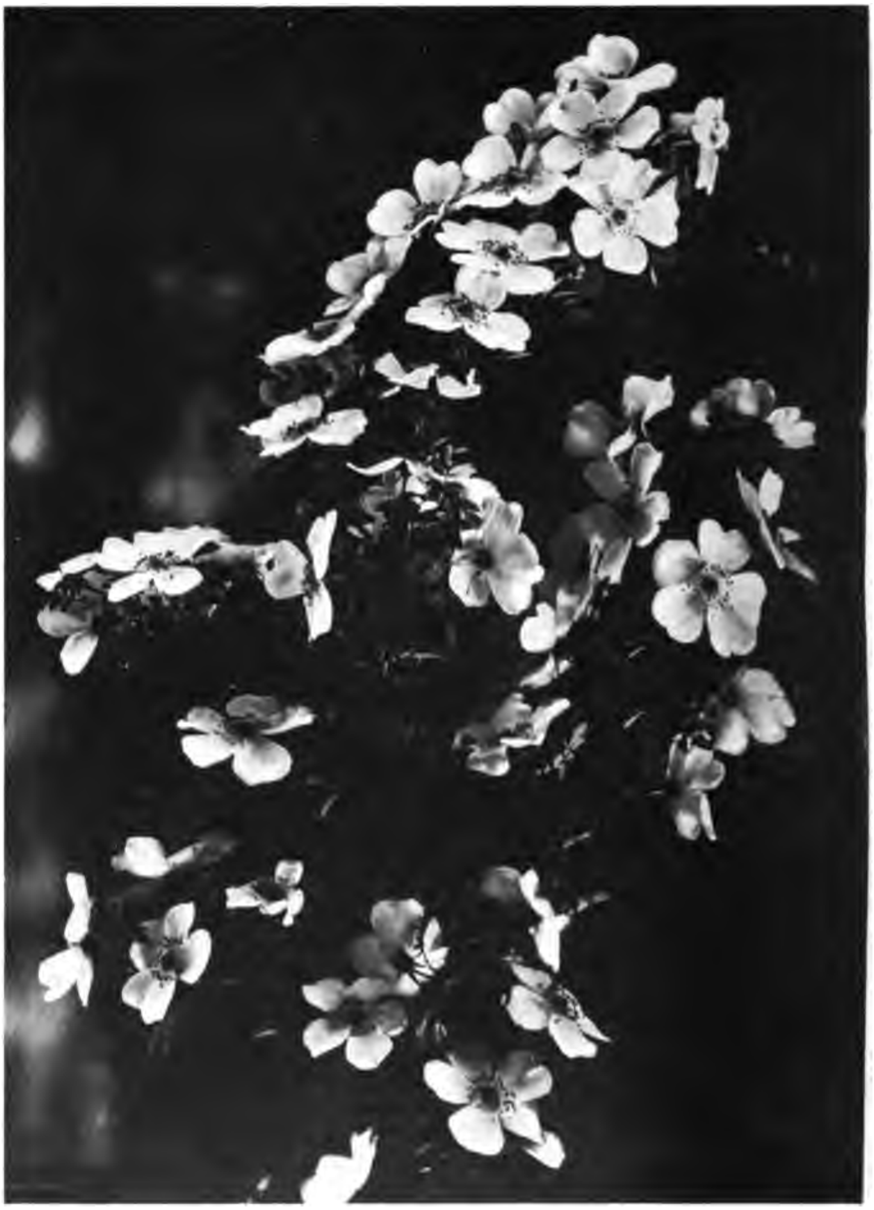


Fig. 5. Western Wild Rose (*Rosa arkansana*)

From these shoots the fairest flowers will be had.

Tea roses and hybrid teas should be pruned more lightly than the hybrids. Perpetuals, ramblers or climbing roses do not require much pruning. All that is necessary is the thinning out of the dead shoots. Roses require lots of cultivation during the growing season and the ground should be loosened up through the plants once a week, and when the watering is done, the ground should be well soaked, not sprinkled.

Insect pests may easily be kept from the rose plants; for the slug or worm which is found eating the leaves, hellebore powder dusted on the leaves will quickly destroy them. If the White Thrip appears, the ground will have been kept too dry and this may be gotten rid of by plenty of watering and syringing of the plants. For exterminating the aphis, frequent spraying with the hose will be found as effective as anything. For mildew, sulphate potassium in proportions of one pound to 40 gallons water will be found very satisfactory.

The number of species of Rosa is extensive and the popular varieties of today are hybrids of the many species from all parts of the world. The hardy garden roses have formerly been the hybrid perpetuals or more properly hybrid remontant—largely hybrids of Rosa Damascena, Borbonica, Gallica, etc., but within the last decade so much advancement has been made in the hybrid tea class that they have become by far the most popular of all garden roses.

The climbing roses are largely hybrids of Rosa Multiflora, Setigera and Wichuraiana, and so much improvement has been made in the latter hybrids during the last ten years, that no garden is complete without a number of varieties of them.

The Japanese roses, Rosa Rugosa, are hardy and of much value for natural plantings; their foliage is entirely distinct and during the latter part of the season their fruit is extremely ornamental.

On the American native roses, until recent years little value has been set unless it has been Setigera and Laevigata, both of which have been used in the hybridization of climbers.

There are a number of the native roses which have proven of great value in natural plantings of shrubbery in parks and other public grounds, among them being Rosa Lucida, Blanda, Nitida and Arkansana. The latter is perhaps the most valuable of any for this purpose.

Hybrid Perpetual Varieties

The list of varieties of this class contains only those which are of the most vigorous habit, though there are many others that may have been found of great value by some rose growers.

Abel Carriere—Rich, velvety maroon shaded with violet, large, full and finely shaped.
Alfred Colomb—Bright, clear red, large and full, form globular and excellent.
American Beauty—Rosy crimson.
Anna de Diesbach—Clear rose.
Baron de Bonstettin—Red, black and crimson.
Baroness Rothschild—Pale rose shaded with white.
Beauty of Waltham—Rosy carmine.
Belle Siebrecht
Captain Christy
Captain Hayward—Crimson-carmine.
Charles Lefebvre—Bright crimson.
Clio—Flesh color.
Duke of Edinburgh—Scarlet-crimson.
Eugene Furst—Velvety-crimson.
Fisher Holmes—Reddish scarlet.
Francois Michelon—Deep rose.
Frau Karl Druschki—Snowy white.
General Jacqueminot—Brilliant red.
George Arends—Pink.
Hugh Dickson—Brilliant crimson.
John Hopper—Rose, crimson center.
Jules Margottin—Bright cherry.
Lady Helen Stewart—Crimson-scarlet.
Madame Gabriel Luizet—Pale pink.
Madame Victor Verdier—Bright cherry.
Magna Charta—Bright pink.
Margaret Dickson—White with pale flesh centers.
Marie Baumann—Bright carmine.
Merveille de Lyon—Pure white.
Mrs. John Laing—Soft pink.
Mrs. R. G. Sharman Crawford—Deep rosy pink.
Paul Neyron—Dark rose.
Pride of Waltham—Delicate flesh color.
Prince Camille de Rohan—Crimson-maroon.
Tom Wood—Cherry-red.
Ulrich Brunner—Bright cerise-red.
Victor Verdier—Rosy carmine.

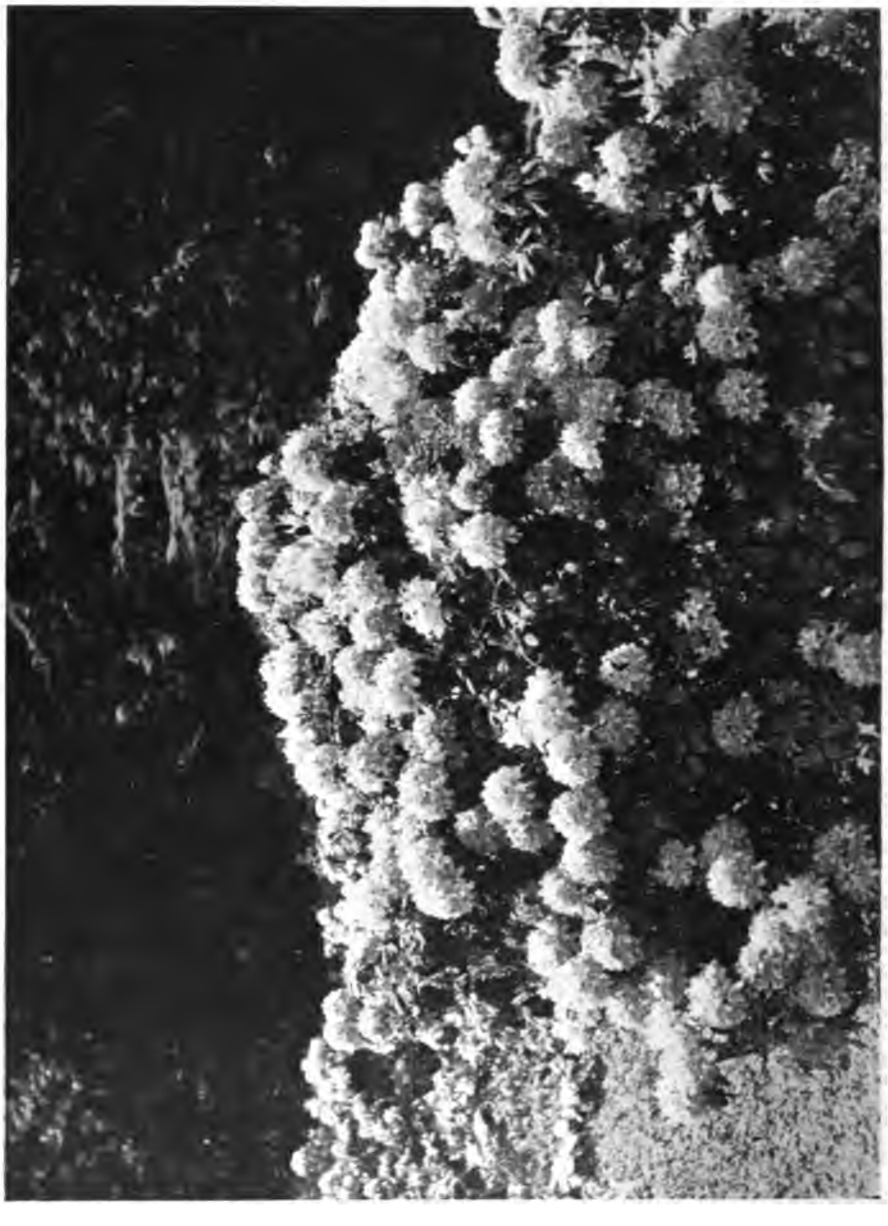


Fig. 6. Hybrid Rhododendron.

Teas and Hybrid Teas

The most of the varieties enumerated are the hybrid tea varieties and are the most popular of all garden roses on account of their continuality of bloom throughout the season. Some tea varieties require protection unless in well sheltered locations.

Arthur R. Goodwin—Coppery orange-red.
Augustine Guinoisseau—Rosy white.
Belle Siebrecht—Rosy pink.
Betty—Coppery rose, shaded yellow.
Caroline Testout—Clear rose.
Countess of Gosford—Salmon pink.
Countess of Shaftsbury—Silvery carmine.
Cynthia—Lemon-yellow.
Cynthia Forde—Rose-pink.
Dean Hole—Carmine shaded with salmon.
Dorothy Page Roberts—Coppery-pink suffused apricot yellow.
Duchess of Albany—Deep pink.
Duchess of Wellington—Saffron-yellow.
Earl of Warwick—Salmon pink.
Edward Mawley—Velvety crimson.
Elizabeth Barnes—Salmon-rose, fawn center.
Etoile de France—Crimson, center fiery red.
General MacArthur—Scarlet-red.
George C. Waud—Vermilion tinted orange.
Gruss au Teplitz—Cinnabar-scarlet.
Instituteur Sirdey—Golden yellow.
Irish Fireflame—Orange splashed crimson.
Jonkheer J. L. Mock—Red and salmon-pink.
Kaiserin Augusta Victoria—Pure white.
Killarney—Rose color.
Konigan Carola—Satiny rose flowers.
La France—Pale peach rose center.
Lady Alice Stanley—Coral rose.
Lady Ashtown—Pale rose.
Laurent Carle—Velvety-carmine.
Liberty—Brilliant crimson.
Lyon Rose—Buds coral red, flowers shrimp pink shaded coral red and chrome yellow.
Mabel Drew—Cream.
Madame Abel Chatenay—Rosy salmon carmine.
Madame Ravary—Golden yellow, open flowers nankeen yellow.
Madame Segond Weber—Bright salmon-rose.
Margaret Molyneux—Saffron yellow.
Marquise de Sinety—Carmine-ochre.
Melody—Saffron yellow with primrose edges.
Mildred Grant—Blush-white tinted with pink.
Mrs. Aaron Ward—Indian yellow.
Mrs. A. R. Waddell—Rosy scarlet buds opening reddish salmon.
Mrs. David Jardine—Bright rosy pink.
Mrs. Wakefield Christie-Miller—Pearly blush.
Pharisaer—Rosy-white, center deep salmon-rose.
Prince de Bulgarie—Silvery-flesh.
Rayon de'Or—Cadmium-yellow.
Richmond—Reddish-scarlet.
Souvenir du President Carnot—Rosy flesh.
Viscountess Folkestone—Creamy-pink.
White Killarney—White.
William R. Smith—Creamy white shaded with pink.

Provence Roses

Rosa centifolia

Cabbage or Common—Rosy pink.
White Provence—Pure white.

Moss Roses

Blanche Moreau—Pure white.
Countess de Murinais—White.
Crested Moss—Rose color.
Crimson Globe—Crimson.
Gloire de Mosses—Blush.

Austrian Briar Roses

Rosa lutea

Austrian Copper—Coppery red (single).
Austrian Yellow—Yellow (single).
Harrisonii—Golden Yellow (semi-double).
Persian Yellow—Deep golden yellow.

Japanese Roses

Rosa rugosa

Belle Poitevine—Rose color.
Blanc Double de Coubert—Double white.
Conrad F. Meyer—Silvery-rose.
Delicata—Soft rose.
Madame Georges Bruant—Paper white.
Repens alba—Flowers single white.
Rugosa—Crimson.
——— Alba—White.

Wichuraiana Roses and Their Hybrids

Alberic Barbier—Yellow buds, opening creamy white, double.
American Pillar—Flowers single; rich pink with a well defined white eye and yellow stamens.
Bonnie Belle—Single pink flowers with yellow stamens.
Coquina—Flowers single, pale pink shading deeper at the tips of the petals.
Dorothy Perkins—Large clusters of rich, soft rose color.
Evangeline—Single flowers, white shaded.
Excelsa—Brilliant scarlet-crimson.
Gardenia—Bright yellow in bud, changing to cream as the flowers open.
Hiawatha—Single bright rich crimson with white eye.
Joseph Lamy—Porcelain white tinted pink.
Kalmia—Pink with white center, single.
Lady Gay—Pink double.

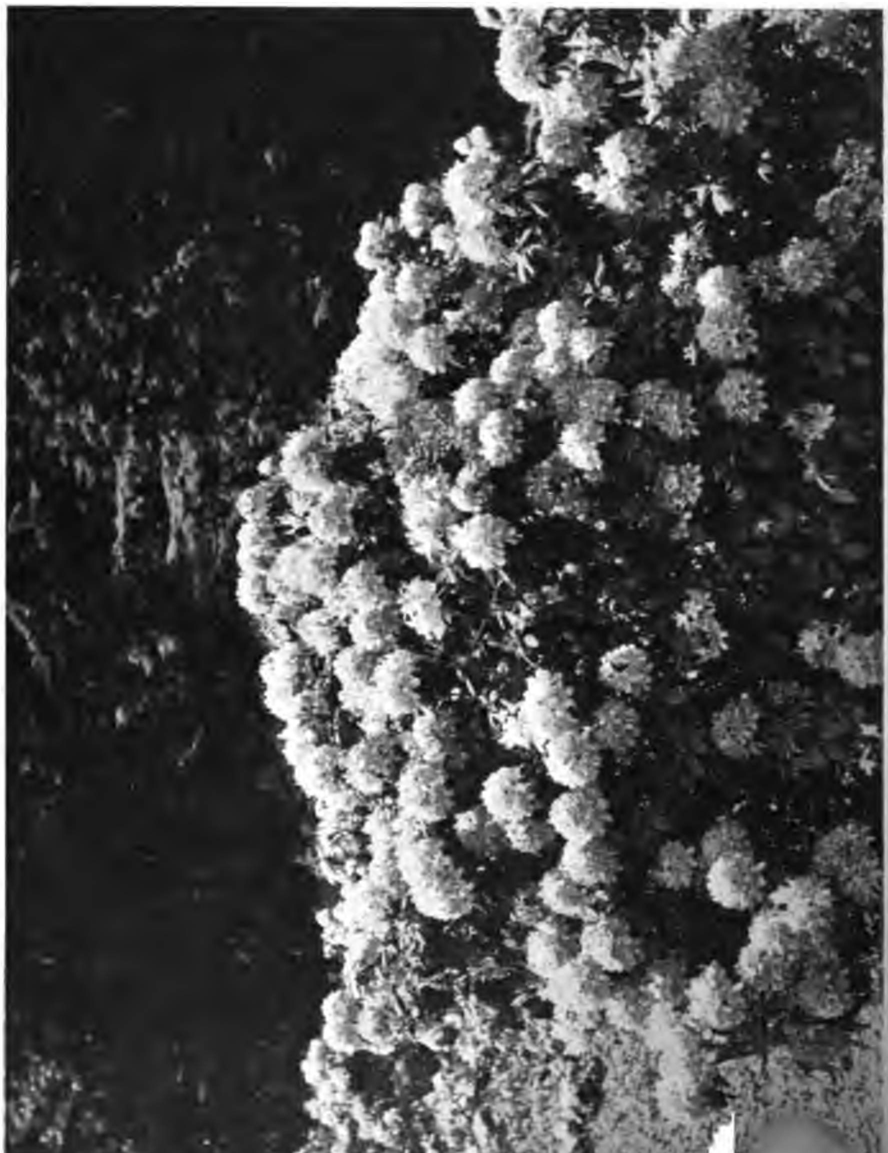


Fig. 6. Hybrid Rhododendron.

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Earl of Warwick—Salmon pink.
Edward Mawley—Velvety crimson.
Elizabeth Barnes—Salmon-rose [illegible] center.
Etoile de France—Crimson, center [illegible] red.
General MacArthur—Scarlet-red.
George C. Waud—Vermilion [illegible] orange.
Gruss au Teplitz—Cinnabar-[illegible]
Instituteur Sirdey—Golden [illegible]
Irish Fireflame—Orange splashed [illegible]
Jonkheer J. L. Mock—Red [illegible] pink.
Kaiserin Augusta Victoria—[illegible]
Killarney—Rose color.
Konigan Carola—Satiny [illegible]
La France—Pale peach [illegible]
Lady Alice Stanley—[illegible]
Lady Ashtown—Pale rose.
Laurent Carle—Velvety [illegible]
Liberty—Brilliant crimson.
Lyon Rose—Buds coral [illegible] shrimp pink shaded [illegible] chrome yellow.
Mabel Drew—Cream.
Madame Abel Chatenay—[illegible] mine.
Madame Ravary—Golden [illegible] flowers nankeen yellow.
Madame Segond Weber—[illegible] rose.
Margaret [illegible]
Marquise [illegible]
Melody—[illegible] edges.
Mildred [illegible] pink.
Mrs. A[illegible]
Mrs. [illegible]

[illegible]

[illegible] with a well [illegible]
[illegible] stamens
[illegible] Belle Single pink [illegible]
[illegible] stamens
[illegible] Flowers single, pale pink [illegible]
[illegible] the tips of the petals
[illegible] Large clusters of [illegible]

Milky Way—Single white with yellow stamen.
Minnehaha—Deep satin rose, double.
Mrs. M. H. Walsh—Snow-white.
Pink Roamer—Pink flowers with silvery white centers.
Sweetheart—Pale pink.
White Dorothy Perkins—White.
Wichuraiana—Type of the group; pure white.

Multiflora Roses and Their Hybrids

Aglaia—Canary yellow flowers.
Blush Rambler—Single flowers; blush.
Crimson Rambler—Crimson flowers.
Fairy—Snow-white.
Flower of Fairfield—Crimson rambler.
Leuchtstern—Bright rose, distinct white eye.
Newport Fairy—Single pink flowers with white eye.
Philadelphia Rambler—Crimson rambler bright in color.
Queen Alexandra—Crimson.
Rubin—Ruby-red.
Tausendschon—Soft pink to carmine rose.
Thalia—Double white.
The Dawson Rose—Pale rose.
Veilchenblau—Bluish purple.
Wedding Bells—Rosy pink.

Sweet Briars

Anne of Gierstein—Dark crimson.
Brenda—Blush or peach.
Lady Penzance—Beautiful soft copper.
Lord Penzance—Soft shade of ecru.
Meg Merrilies—Crimson.
Refulgence—Semi-double flowers, scarlet.

ROSE DISEASES

Black Spot

Actinonema rosae

Produces purplish or discolored areas of considerable size on the surface of the leaves, causing them to drop.

See *Mildew*, this section.

Cane Blight

Affected wood turns a dark purplish or black color, with a sharply defined line between the sound and diseased bark.

This trouble is due to a fungus which is apparently undescribed in plant disease literature. It infests stubs left in pruning and often develops down into the main branches, seriously injuring the bushes.

May be largely avoided by proper pruning.

Crown Gall

This is the common crown gall which affects many species of plants.

See under *Apple Diseases*.

Rose Leaf Blotch

Actinonema rosae (Lib.) Fr.

Nearly as common as the powdery mildew. Irregular brown spots appear on the upper surface of the foliage.

Climbing sorts are likely to be more immune than bush kinds.

Spray with Bordeaux early before blossom buds begin to form. Secure healthy stock for planting.

Reference

Duggar, Fungus Diseases of Plants.

Rust

Phragmidium subcorticium

Affects the hybrid roses, causing the leaves to turn yellow and fall, with black or bright orange pustules of rust spores on the under side.

See *Mildew*, this section.

Mildew

Sphaerotheca pannosa and *S. humuli*

Roses are commonly affected with two different powdery mildews quite different in appearance from one another. The first named is seen most characteristically on the hybrid roses and is particularly severe on the Crimson Rambler. It forms a thick, dense, felty white growth upon the green shoots, buds, and young leaves more than on the surface of the older leaves. This does not affect the tea roses. The latter are particularly susceptible, however, to the second fungus named, which produces a more delicate fungus growth upon the leaves and blossoms rather than the stems, giving them a crinkled appearance.

The most effective treatment for these rose troubles consists in spraying the bushes occasionally with a solution of sulphide of potash (liver of sulphur), one ounce to three gallons of water. Spray the under side of the leaves as well as the top and make up the solution fresh each time the spraying is done. If the bushes are also affected with plant lice an addition of tobacco extract or cheap soap may be made to the spray. In bad cases of mildew further relief may be obtained by dusting the bushes thoroughly with flowers of sulphur while they are still wet with the spray.

Different varieties vary greatly in susceptibility, and the ordinary grower will find the most satisfaction by discarding the most susceptible kinds and growing others which are less liable to disease.

R. E. SMITH,
Calif. Exp. Sta. Bul. 218.

References

California Experiment Station, Bulletin 218.

Duggar, Fungus Diseases of Plants.

ROSE PESTS

Large Rose Aphid

Macrosiphum rosae Linn

General Appearance

A large aphid, being green and pink in color. The apterous forms have dark cornicles and the joints of the legs and antennæ dusky, while in addition to these the thorax, entire antennæ and blotches on the sides of the abdomen of the winged forms are dark. Length, two to three mm. Readily distinguished from the other common green rose aphid by the large size and pink forms.

Life History

Works on the young shoots and buds of the roses, almost throughout the entire year. Especially troublesome in the early spring during the months of April and May. Not so serious a pest on roses as is the small green louse (*Myzus rosarum.*)

Food Plants

Roses, wild and cultivated.

Control

In order to save the buds it is sometimes necessary to spray the bushes with a soap and tobacco spray. Washing the bushes every day with a high pressure of water will keep them off and is a practical method of control.

Natural Enemies

Natural enemies completely eliminate the attacks of this pest by the middle of summer.

Fuller's Rose Beetle

Aramigus fulleri Horn. (Family Otiorhynchidæ)

General Appearance

The adults vary from gray to very dark brown in color and from three-eighths to one-half an inch in length. The eggs are about one-twentieth of an inch long, pale yellow and laid in rows. The larvæ are milky white and without legs. The pupæ are also white.

Life History

The eggs are laid in clusters in secluded places on the trunks of trees or at the base of the trees or plants often close to the ground. The young white grubs are subterranean in their habits, doing great damage to the roots of many plants. The adults when seen during the day are very sluggish. They have no power of flight. Much damage is done to plants by this pest unknown to the farmer, owing to the fact that the larvæ work underground and the adults feed at night.

Food Plants

Foliage of citrus trees, roses, oaks, camellias, palms, *Canna indica* and the roots of strawberries. Young or newly budded citrus trees are often greatly damaged by this pest.

Control

The larvæ, like all subterranean pests, are difficult to control, but thorough cultivation and hoeing close to the plants are great aids. In light sandy soil, carbon bisulfid is efficient. The adults being unable to fly are easily kept from trees by means of a cotton or tanglefoot band around the trunk, but are very troublesome to low plants and bushes where such methods are impracticable. Poison sprays such as arsenate of lead must be resorted to in such cases to save the foliage.

E. O. ESSIG

RASPBERRY HORN TAIL. See *Raspberry Pests.*

Rose Scale

Aulacaspis rosae Bouche.

General Appearance

The female scales are nearly circular with very irregular edges and white to gray in color with reddish body. This scale multiplies very rapidly and clusters in great numbers on the stems of roses and kindred plants, especially about the crowns.

Somewhat difficult to control. Badly infested canes should be cut out and burned.

Spray with kerosene or carbolic acid emulsion or lime-sulphur during the winter.

Reference

Monthly Bulletin California Commission of Horticulture II., 1 and 2.

Rose Snout Beetle

Rhynchites bicolor Fab. (Family Rhynchitidæ).

General Appearance

A small bright red snout beetle, with head, snout and legs black. The average length of the females is about one inch. The males are noticeably smaller than the females.

Life History

The beetles hibernate over winter in sheltered places and appear early in the spring. The females roll up the edges of the leaves into small pockets like miniature thimbles into which the eggs are laid and the young reared. The larvae and adults feed upon the foliage, the latter also puncturing the fruit of blackberries and raspberries with their snouts or bills.

Food Plants

The beetles confine their attacks almost wholly to the wild rose, though they may occasionally work great damage to cultivated roses and to berries. The adults also feed upon oak leaves and grapevines.

Control

As this pest is normally a leaf eater it may be controlled by liberal applications of arsenical sprays. These meet all requirements, except where they damage the fruit of berries, but even such attacks could have been prevented by spraying the vines before the berries began to ripen.

E. O. Essig

Small Green Rose Louse

Myzus rosarum Walk

General Appearance

A very small species, not nearly as large as *Macrosiphum rosae*; green throughout except dark markings on the winged forms. It is often mistaken for the larger species.

Life History

A very serious rose pest at times, and especially bad in the summer months. It breeds very rapidly, collects in great numbers upon the leaves and excretes a great amount of honeydew which smuts the bushes. The worst rose pest in many parts of the state.

Food Plants

Roses, usually more serious on climbing varieties. Attacks the leaves and buds and may prevent the production of flowers.

Natural Enemies

Syrphid flies do considerable work upon this species, but the natural enemies are not numerous enough to check the ravages until late in summer.

E. O. Essig

Other Insect Enemies

The rose is attacked by various insects which are common to fruit trees. Among them are San Jose scale, greedy scale, oyster-shell scale, red spider, apple-leaf hopper, etc. These will be found treated under *Apple Pests*. Frosted scale will be found under *Prune Pests*.

LANDSCAPE GARDENING

By John W. Duncan

Landscape gardening covers a broad field and considerable study, taste and judgment are required on the part of those who undertake the business. Landscape gardening of the best order is the beautification with as little change as possible from what nature has already done. Mere planting and grading does not constitute landscape gardening and the proper grouping or clustering of shrubs and trees make really the most picturesque landscapes. Some of the best landscape scenes are found in this Western country and there is a wide field here for the artificial gardener. The great wealth of native trees, shrubs and other plants found all over this section of the country adds greatly to the work and simplifies the problem. A general theory or plan is necessary before there is any grading or planting, as it is necessary to work out the whole from the well studied out plan which should be made in the beginning.

The indiscriminate growing of shrubs or plants often spoils a beautiful landherent love of nature is ry to the best success ener, who must also varieties of trees, ts, besides having ge of grading, drain- ing and the like. Care be taken to avoid scattered The best planting of trees and bs is accomplished by the grouping of the suitable varieties which can only be decided by a thorough study of the location.

Single or individual trees or plants may be used to heighten an effect. It is best always to widen out or leave as much open land as possible. Walks and drives are necessities and therefore should be hidden as much as possible from the landscape. Where there are buildings, the grounds must conform to them and it is a problem to work out the best possible plantings, so that these buildings will not occupy the most prominent part of the landscape picture. Obtrusive or undesirable features should be hidden by the artificial planting of trees and shrubs. Natural plantings should be adhered to as much as possible and the planting of different trees should be carefully studied so that when they have attained their growth they will accomplish the purpose for which they were intended.

Avoid as much as possible the making of designs or the planting of trees or hedges which will constantly require cutting or pruning into shapes which do not agree with nature. The variety of trees and shrubs should be restricted to those that are perfectly hardy and that will adapt themselves to the locality.

In the planting of a large space it is well to have as much open expanse as possible, so as to produce a wide landscape effect. The tall growing trees should be kept in the background with the dwarfer growing varieties in front graduating to irregular belts of shrubs, so that one may look over the foreground to an irregular background of the larger trees behind.

The best decisions of the varieties to

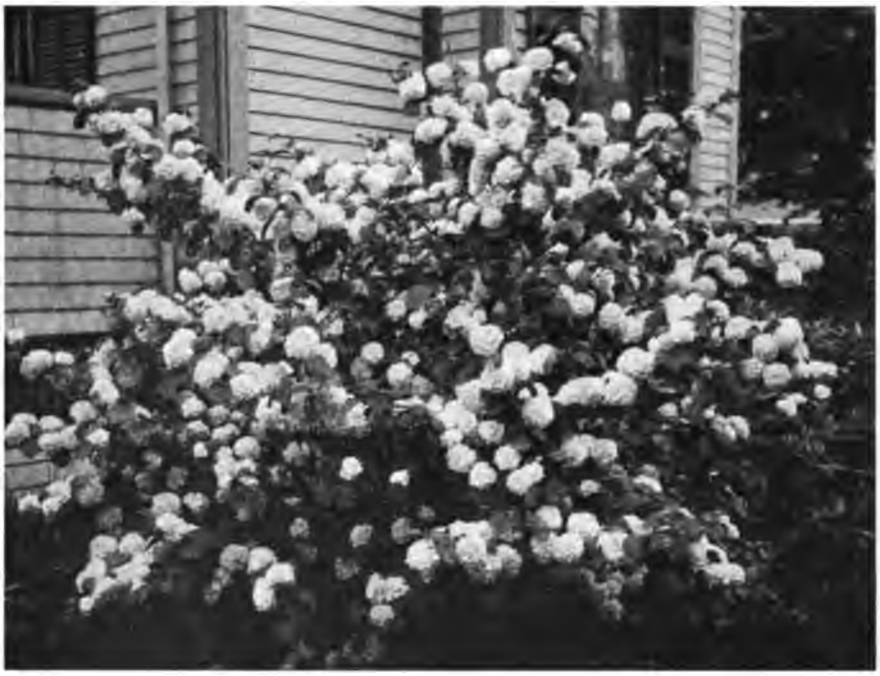

Fig. 7. Japanese Snowball (*Viburnum plicatum*)

use may always be made during the summer when the different deciduous and evergreen subjects may each and all be readily seen to the best advantage, when their leaves are fully expanded. At such times, too, any defects may be noted for remedying at some later period.

Conifers and all evergreen trees may be used to good advantage and should be, where plenty of space is available, planted in large groups; so as to avoid a patchy appearance. Consideration should be given to the location of summer trees with particular individuality, so that they can show the same to the best advantage during the whole of the season. Again, many of the trees or shrubs which have different color of bark or foliage should be grouped so that they will emphasize their particular feature and the particular season at which these features may show to the best advantage.

A water effect is one of the most pleasing and almost essential features of a fine landscape, whether it is a lake or river effect; either will go a long way toward the effectual natural planting and making of a fine landscape. Many times good effects can be worked out by utilizing springs or small rivulets where there were practically no water effects formerly. In water scenes, the judicious planting of trees and shrubs on the borders or islands will greatly enhance the natural landscape and many water plants may be introduced to make the effect more gardenesque.

In the planting of small estates or home grounds, the mistake generally made is the scattering too much of the trees and

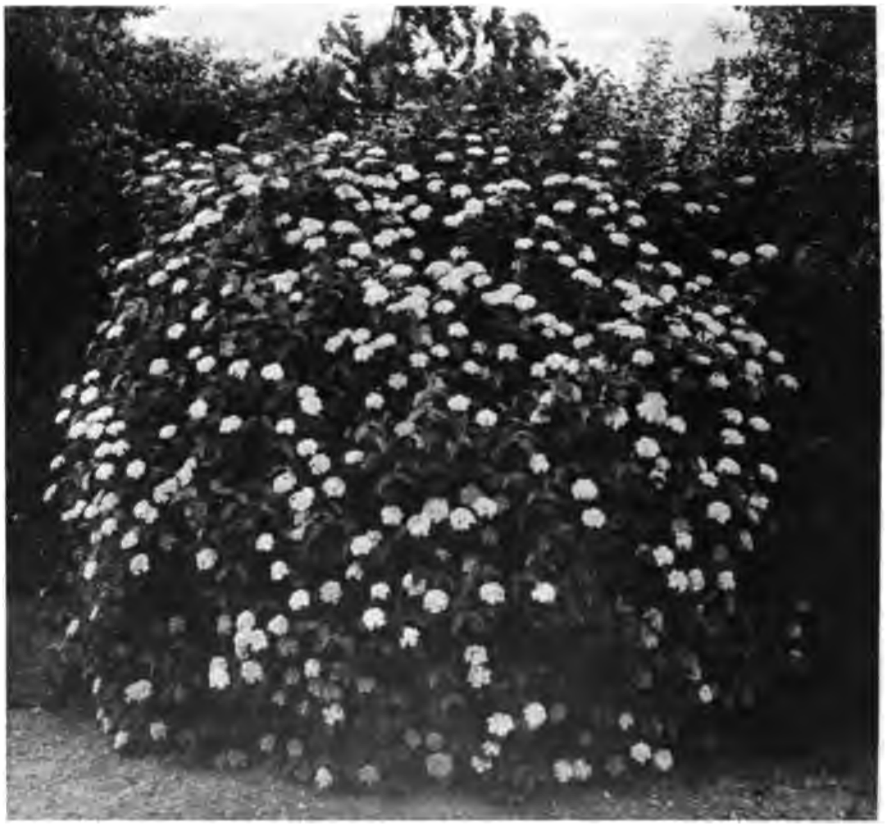

Fig. 8. Viburnum pubesceus.

shrubbery through the lawn, as already mentioned. The finest effects can be made by the judicious border planting, leaving as much open space forming vistas from the house piazza or views from the various windows, so that the grounds will, in reality, look much larger than they really are.

History and General Principles of Landscape Gardening

L. P. Jensen

History

The history of the gardens of the ancients is more or less fabulous.

The Jewish paradise is supposed to have been situated in Persia, of great extent, watered by a river and abounding in timber and woods. Paradise seems to have borne some resemblance to a pleasure ground of the modern taste. The gardens of the Hesperides were situated in Africa near Mt. Atlas, or according to some, near Cyrenaica. They are described as lying in places eighteen fathoms deep, steep on all sides, two stadia in diameter and covered with trees of various kinds planted very close together. The principal Jewish garden was King Solomon's. This garden is said to have been quadrangular and surrounded by a high wall. It contained a variety of plants, such as "the hyssop which springeth out of the wall," odoriferous and showy flowers as the rose, lily of the valley, calamus, camphire, spikenard, saffron and cinnamon; trees as the cedar, pine and fir, and fruits, as the fig, grape, apple and pomegranate. It contained water in wells, and in living streams. The situation of the garden was probably near to the palace.

The gardens of Cyrus, at Babylon, 2,000 years B. C., were of square form and according to Strabo, each side was 400 feet in length, so that the area of the base was nearly four acres. They were distinguished by their romantic situations, great extent and diversity of uses and were reckoned in their day among the wonders of the world. They were made to rise with terraces constructed in a curious manner one above the other in the form of steps, and supported by stone pillars to a height of more than 300 feet, gradually diminishing till the area of the upper surface was reduced considerably below that of the base. The garden of the Phacacian King, Aelianus, was situated on the island of that name, probably an Asiatic island. It is minutely described by Homer in his "Odyssey," and may be compared to the garden of an ordinary farm house in point of extent and form, but in respect to variety of fruits and vegetables was far inferior. It embraced the front of the palace, containing less than four acres surrounded by a hedge and interspersed with three or four sorts of fruit trees, some beds of vegetables and some borders of flowers. It contained two wells, one for the garden, and the other for the palace.

The Persian and Grecian gardens of this period seem to have been nearly of the same description as those mentioned.

We know little of the gardens of the Augustan age of Horace and Virgil, generally thought to be that in which taste and elegance were eminently conspicuous. From the descriptions of the villas Laurentinum and Thusculum, by the younger Pliny, we gain a general idea of the gardens of the Romans. The Laurentinum was a winter residence on the Tiber, between Rome and the sea, now called San Lorenza, seventeen miles from Rome. The garden was small and is but slightly described. It was surrounded by hedges of box and rosemary, and there were platforms and terraces; figs, mulberries and grapes were the fruits. Pliny's Thusculan villa was situated in a natural amphitheater of the Appenines whose lofty summits were clothed with forests of oak and their fertile sides covered with cornfields, vineyards and villas. Pliny's description of this villa is of importance as showing what was esteemed as good taste in the gardens and grounds of a great Roman nobleman of the first century, under the reign of Trajan, when Rome was still in her glory.

The Thusculan gardens may have contained from three to four acres and lay around the palace. The terrace is described as in the front of the portico and near the house; from this descended a

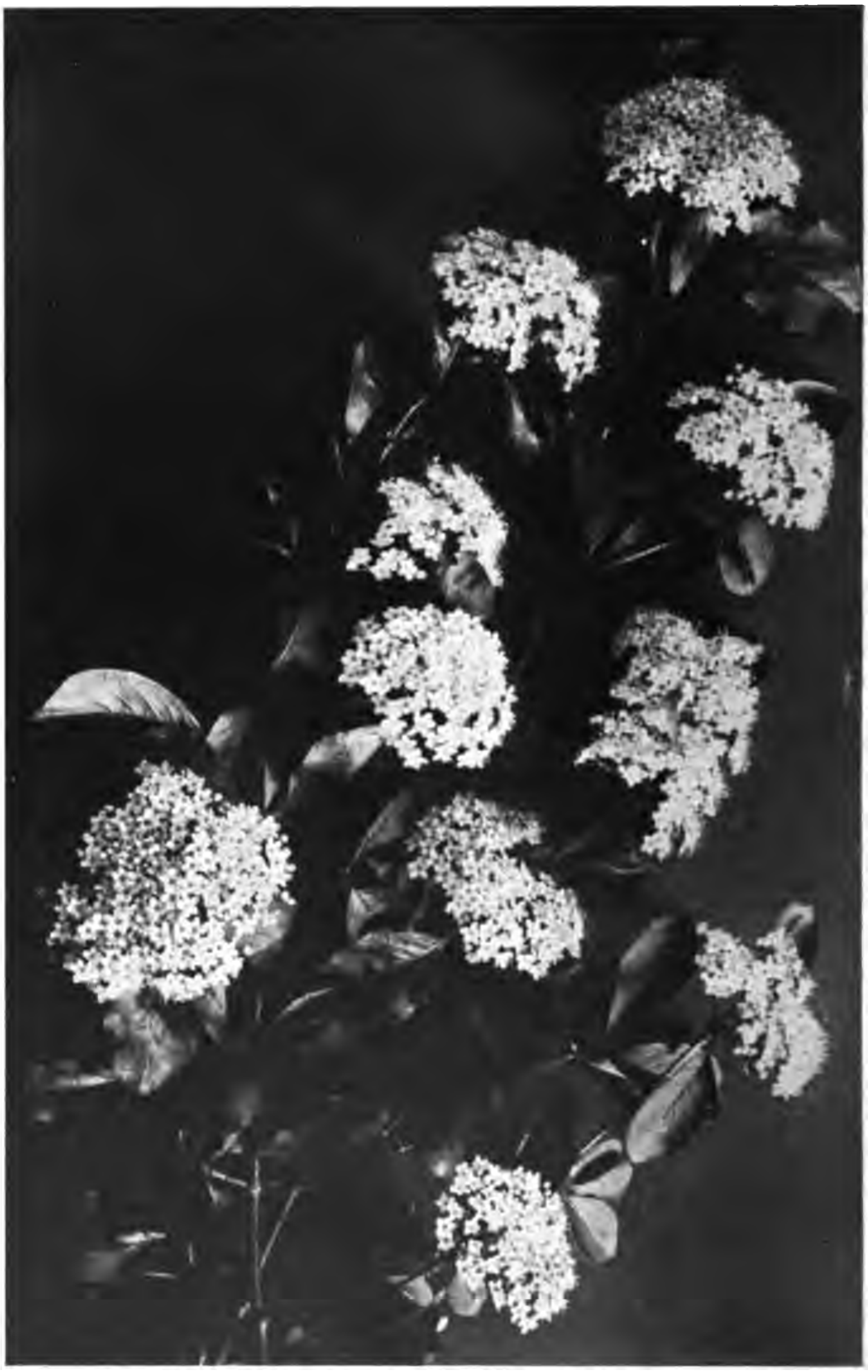

Fig. 9. Black Haw (*Viburnum prunifolium*)

lawn covered with acanthus, supposed to have been a sort of moss and adorned with figures of animals cut in trees. This lawn was again surrounded by a walk enclosed with evergreens sheared into a variety of forms. Beyond this was a place for exercise ornamented in the middle with box trees sheared as before into numberless different figures, together with a plantation of shrubs kept low by clipping. The whole was fenced in by a wall covered with box, rising in different ranges to the top. Another quarter of the house compassed a small space of ground, shaded by four plane trees with a fountain in the center, which, overflowing a marble basin, watered the trees and the verdure beneath them. Opposite to another part of the house was a plantation of trees in the form of a hippodrome, formed of box and plane trees alternately planted, and connected together with ivy. Behind these were placed bay trees and the ends of the hippodrome, which were semi-circular, were formed of cypress. The internal walls were bordered with rose trees and were in a winding direction, which, however, terminated in a straight path, which again branched into a variety of others separated from one another by box-hedges. These were sheared into a variety of shapes and letters, some expressing the name of the master, others of the artificer, while here and there small obelisks were placed intermixed with fruit trees, sheared as already described. At the upper end of the garden was an alcove of white marble, shaded by vines and supported by marble pillars, from the seat of which recess issued several streams of water intended to appear as if pressed out by the weight of those that reposed upon it, which water was again received in a basin so contrived as to seem always full without overflowing. Corresponding to this was a fountain that threw water to a considerable height and which ran off as fast as it was thrown out. An elegant marble summer house, opening into a green inclosure and furnished with a fountain similar to the one last described, fronted the above. Throughout the walks were scattered marble seats, near to each of which was a little fountain and throughout the whole, small rills of water were artificially conducted to entertain the ear with their murmur as well as to water the garden.

It will be seen later that the garden of Pliny had a striking resemblance to the French and Dutch style of gardening of the 16th and 17th centuries. After the fall of the Roman Empire little is known of the art of gardening up to the beginning of the 16th century when it was revived by the Medici family in Rome. These gardens were geometrical designs and served as models for other famous gardens which succeeded them until the change of taste in gardening in England about 1760.

The so-called Dutch or Holland style differs but little from those already mentioned. At the end of the 16th century the French began to copy the gardens of the Italians, and during the reign of Louis XIV, 1651-1715, Le Notre improved and settled the French style in his laying out of grounds and gardens. His taste and style continued in full repute for upwards of a century. Hirchfeld, in his "Theorie der Gartenkunst," Vol. 1, 1779, observes that "if Le Notre had been born under any other monarch than Louis XIV, his taste would in all probability never have spread nor his name been known to posterity. But that age in which a feeling for the fine arts had begun to awaken in men's minds, together with the personal character of this monarch, was favorable to pomp and brilliancy. The nation and the court wished to be dazzled and enchanted by novelty and singularity; and though there certainly was nothing in Le Notre's manner that had not before been displayed in France and Italy and with the exception of parterres, even by the Romans, yet the grand scale and sumptuous expense of the plans surpassed everything before seen in France, and produced precisely the desired end. His long clipped alleys, triumphal arches, richly decorated and highly wrought parterres, his fountains and cascades with their strange ornaments, his groves full of architecture and gilt trellises, his profusion of statues, all these wonders, springing up in a desert-looking open country, dazzled and enchanted every class of observers." The principal works of Le Notre are Versailles, which cost nearly 200 million francs, Trianon, St. Cloud, Chantilly, and the celebrated terrace of Saint Germain. He went to Italy and England, and the rest of Europe adopted his style. He died in 1700.

The Romans abandoned England to the Saxons in the beginning of the fifth century and the art of gardening, which had revived in France under Charlemagne, was probably introduced into England at the end of the eleventh century. During the following centuries, until after the hundred years of dispute between the houses of York and Lancaster, we find little or no record of gardening until the time of Henry VIII. when the royal gardens of "Nonsuch" were laid out. These gardens were said to have been cut and divided into several alleys, quarters and rounds, set about with thorn hedges. On the north side was a kitchen garden surrounded by a wall

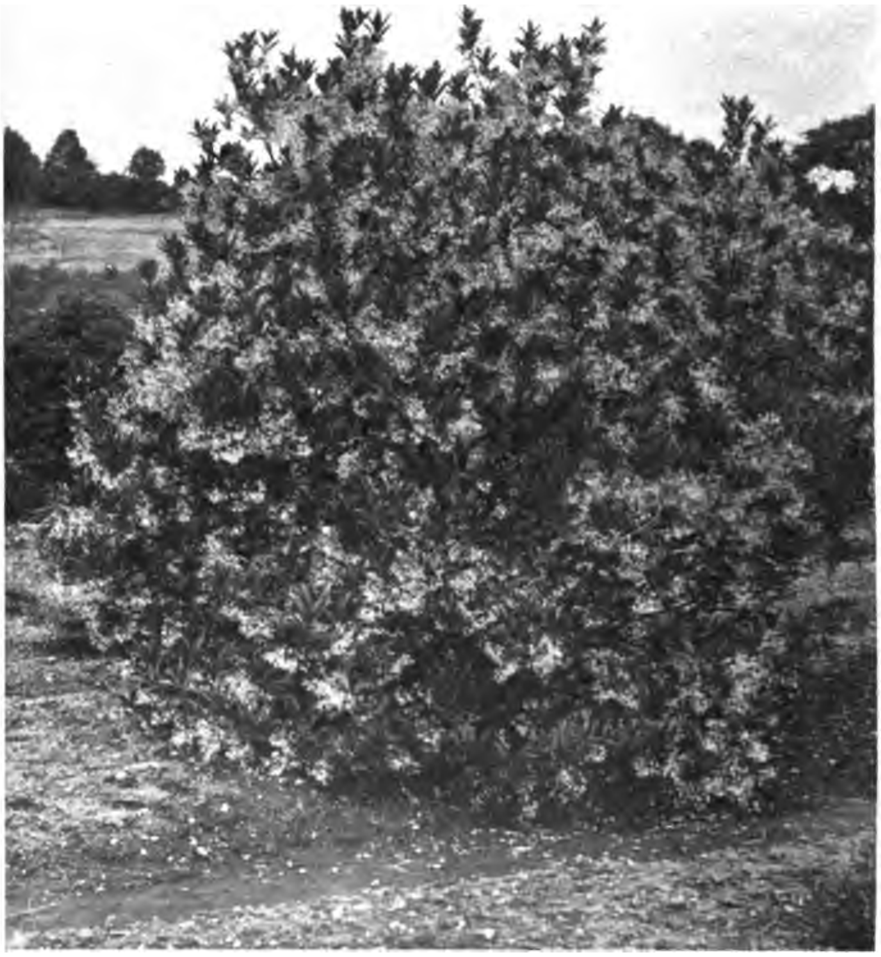

Fig. 10. White Fringe (*Chionanthes virginica*)

14 feet high; on the west was a wilderness containing ten acres. In the gardens were pyramids, fountains and basins of marble, one of which was set round with six lilac trees. Besides the lilacs there were 144 fruit trees, two yews and one juniper; in the kitchen garden were 72 fruit trees and one lime tree; lastly, before the palace was a neat bowling green, surrounded with a balustrade of strong stone. This was in the year 1650.

Lord Francis Bacon attempted to reform the national taste in gardening during his time, but apparently with little immediate success. He wished still to retain the shorn trees and hedges, but proposed winter or evergreen gardens and rude or neglected spots as specimens of wild nature. "As for the making of knots and figures," said he, "with divers colored earth, they be but toys. I do not like images cut out in juniper and other garden stuff, they are for children." Sir Henry Wotton said the garden at Lord Bacon's was one of the best he had ever seen, either at home or abroad. It is allowed on all sides that Joseph Addison and Alexander Pope prepared for the new art of gardening the firm basis of philosophical principles. Addison had a small retirement at Bilton, laid out in what may be called a rural style. Pope attacked the verdant sculpture and formal groves of the ancients with the keenest shafts of ridicule, and in his "Epistle to Lord Burlington," laid down the most just principles of art, the study of nature, of the genius of the place, and never to lose sight of good sense.

But it was reserved for William Kent to carry their ideas more extensively into execution. It was reserved for him to realize the beautiful descriptions of the poets for which he was peculiarly adapted by being a painter as the true test of perfection in landscape gardening is that a painter would choose it as a composition. Kent was born 1675 and died 1748. Kent was succeeded by Launcelot Brown. Brown was bred a kitchen gardener, but was afterwards head gardener at Stowe. He was extensively employed by the nobility. His new plantations were generally void of genius, taste and propriety. His creations were all surrounded by a narrow belt, and the space within was distinguished by numbers of round or oval clumps, and a reach of one or two tame rivers on different levels. This description in short will apply to almost every place in England laid out from the time about 1740, when the passion commenced for new modeling country seats, to about 1785 or 1790, when it, in a great measure, ceased. The leading outline of this plan of improvement was easily recollected and easily applied. The great demand produced abundance of artists and the general appearance of the country so rapidly changed under their operation that in the year 1772 Sir William Chambers declared that if the mania were not checked in a few years longer there would not be found "three trees in a line in the entire country." This system was, in fact, more formal than the ancient style, which it succeeded, because it had fewer parts. The ancient gardens had avenues, alleys, platoons, circular masses, rows double and single, all from one material wood, but the new style, as then degraded, had only three forms, the clump, the belt and single tree.

The good sense of the country soon revolted at such monstrous productions, and proprietors were ridiculed for expending immense sums in destroying old gardens, avenues and woods, and planting in their place young clumps for no other reason than that it was the fashion to do so. The writers who ventured to protest were principally: George Mason, in his "Design in Gardening," 1765; William Sheustone in "Unconnected Thoughts on Gardening," 1764; Whately in "Observations on Modern Gardening," 1771; William Chambers in "Dissertation on Oriental Gardening," 1772; William Mason, the poet, in "The English Garden," 1772-1789; and especially the writings of Richard Paine Knight, Sir Uoedale Price and Rev. William Gilpin, 1780-1800.

The change of taste in gardening seems to have been materially aided by accounts of Chinese gardens, about the end of the

17th century. According to these descriptions, the Chinese gardens were laid out in the natural style.

The gardens of Japan are original and unique. The Japanese landscape gardener studies a natural landscape and reproduces it in miniature, his composition including mountains, lakes, streams, hills and woods. While these gardens are often very small, they are artificially arranged, and for this reason well worthy of study, as the principles employed may be utilized in the laying out of ground on a larger scale.

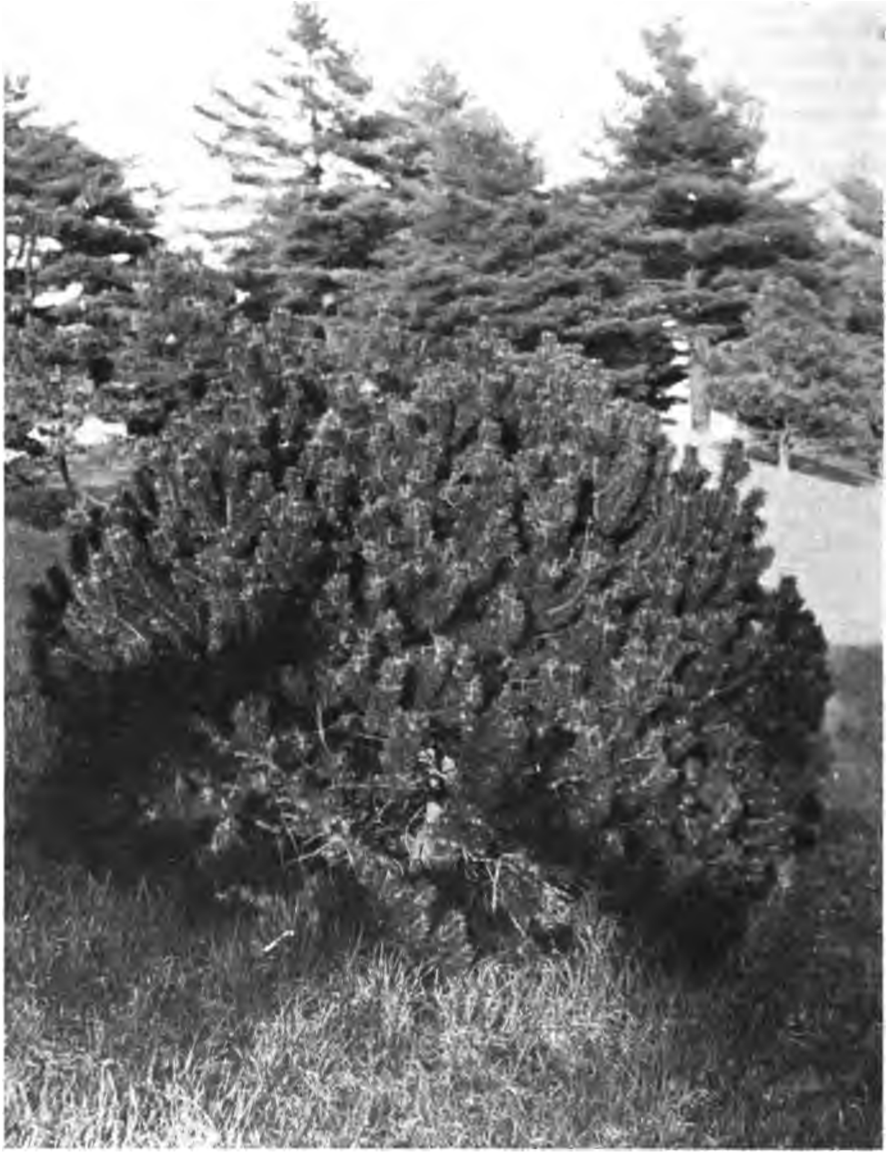

Fig 11. Dwarf Mountain Pine (*Pinus monticola*)

Humphrey Repton was the first who took unto himself the title of landscape gardener and the first to lay down fixed principles for the art. His published works are still indispensable to the landscape gardener. His career as a professor began about 1788. The elegant, sensible style soon rapidly spread over continental Europe and was introduced into America by Andrew Parmentier, who came here from Belgium about 1824. He was followed by Andrew Jackson Downing, whose "Landscape Gardening" and "Letters to the 'Horticulturist,'" are well known to have greatly assisted the advancement of landscape art in America. But the one who carried the art to its highest point was Frederick Law Olmsted. His writings are classics on outdoor art, and his work in designing parks and other grounds were object lessons which have paved the way for the wave of interest in landscape gardening and civic improvement, which is now becoming general throughout the country.

General Principles

The naturalistic methods of gardening are undoubtedly the most interesting to the American people, and I think the formal arrangement should be confined to restricted areas, disconnected from the other parts of the ground. In connection with magnificent architecture and considered as part of the architectural scheme, this kind of gardening is perfectly fitting.

The aim of the landscape gardener is the formation of pictures and the principles governing his works are the same, whether he is working on a large park or on the area of a city lot. The materials are earth, rocks, woods and water. The buildings, roads and walks are artificial features necessary for the comfort and convenience of man.

The first step in the arrangement of any landscape is the making of a plan. This plan should give every detail of grading and planting arrangement. It should be made to a scale large enough if possible to give the location of each individual plant. It should show the location of buildings, roads, paths, drains and all existing and proposed features. This plan should be accompanied by written instructions and specifications, and it should be conscientiously followed as a guide in future operations to prevent incongruities and confusion.

The laying out of the ground should be done in the following order: Locating and building the residence and other structures, grading, laying drains, making roads and paths, planting of trees and shrubs, and lastly, the finishing of the lawn. The location of the residence and the planting near it should be very carefully considered. Generally the house is finished and the grading done before the laying out of the grounds is thought of, whereas the proper way is to consider the location of the building in connection with the planning of the grounds. Planting about the base of a building helps to connect it with the lawn upon which it stands and softens the stiff, regular lines. This planting should consist of hardy material, which will be effective, even in winter.

Porches and parts of the building ought to be planted with hardy vines for purposes of both privacy and comfort. The lawn should be as spacious as possible to give extent to the place, and should have boundaries of closely planted trees and shrubs in irregular masses, the foreground of which may be planted here and there with masses of herbaceous and annual flowers carefully arranged so as not to cause a spotted effect.

Outbuildings should be partially screened by mass plantings so as to show only those parts of them which will add to the beauty of the composition. Avoid the common fault of scattering plants all over the grounds without reason or thought.

In the arrangement of the plantation be careful to study the natural growth of the plants such as height, form, rapid or slow growth, texture and color of the foliage and season of bloom. While most plants have green leaves there are great differences in the shades of green, which differences must be carefully considered

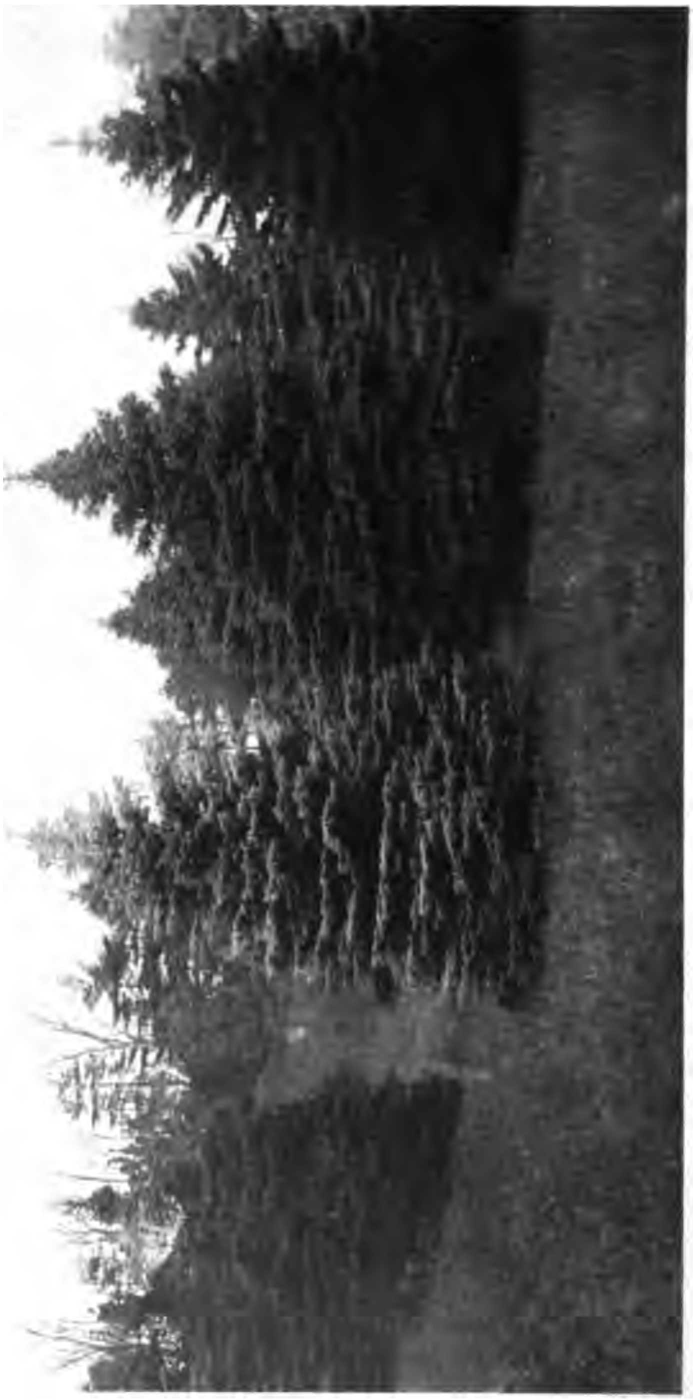

Fig. 12. White Spruce (*Abies alba*)

for the sake of harmony in the landscape composition.

Such plants as the blue spruce, purple beech, plum and birch, golden elder and all plants with highly colored leaves, should be used very carefully, as should also many of the plants like the weeping mulberry, weeping elm and the Kilmarnock weeping willow.

Take advantage of the beautiful points in the surrounding landscape by opening vistas and plant tall growing trees and shrubs, to shut out undesirable objects.

When planting groups and masses, do not indiscriminately mix the plants. Plant several of each kind or variety together, and where more than one kind are used in a group, let them mix slightly to avoid the formation of stiff, regular lines.

The proper location of drives and walks is an important consideration. They should be as direct as possible and planned for convenience as well as beauty. Except on very small places, a slightly curving road or walk is generally more pleasing than a straight one. Every road or walk should have a distinct aim, such as buildings, pleasing view points, etc. Large bends will only be justified by natural obstacles, such as rocks, water, or groups of trees. The curves should be easy, and gracefully follow the natural contour of the ground. If possible, do not allow roads and walks to run through the center of an open lawn or meadow, but keep them to one side and plant trees and shrubs irregularly along their sides in such manner as to prevent long stretches of either road or walk from being seen from any point of view.

The entrance to a place should be as simple as possible, and in keeping with the general lay of the ground. Water is one of the most effective features in the landscape, and should be introduced whenever possible. The pond and lake give a peacefulness to the scene not otherwise easily acquired, and the rippling brook and the waterfall enliven the woods with their murmurs, the former never resting as it runs along from shadow to sunshine. The planting of the margins of streams and lakes gives an opportunity for introducing a great variety of plants which could not otherwise be grown, such as water lilies, cat-tails, calamus, Japan iris, and scores of other moisture-loving plants. The making of artificial ponds and lakes and the planting of them to fit natural surroundings is vastly more difficult than the arrangements of ordinary ground surfaces. They are apt to be made stiff and formal in their outline, examples of which are to be found in abundance in our parks and pleasure grounds.

A good way is to study Nature's arrangement, noting carefully how she goes about the formation of her duties, the obstructions in the streams causing the formation of natural dams, and how she forms her islands in streams and lakes. One may thus gain much valuable information, and by following it he will be able to make and plant the natural water features of his garden.

Bridges should be of a pleasing, simple design, harmonizing with their surroundings. No bridge should be built unless there is a reason for it. Other structures, such as summer houses, arbors and boat houses, should be very carefully placed. If the design is simple and in harmony with its surroundings, the structure may add materially to the beauty of the landscape, but if not properly designated or placed without apparent reason for its position, it had better be left out, as it would only spoil what perhaps otherwise was a fine composition.

In the planting of the naturalistic garden or landscape, we should mainly rely on plants of undoubted hardiness, and for this reason our native plants are splendidly adapted. We have a wealth of native material in our woods, fields and meadows, suited to every locality, soil and condition. Nature is the best teacher. Get acquainted with the native material first, then visit as many good gardens as possible and learn how to use this material to the best advantage.

[illegible] plants as low [illegible] on dry hillsides, as [illegible] but select plants which are [illegible] adapted to the climate, soil and situation of your garden. Use American grown plants in your plantations if [illegible]. Do not attempt to [illegible] trees and shrubs from [illegible] your gardens, they will [illegible] produce a stunted [illegible] plants may be collected [illegible] successfully.

[illegible] many beautiful hardy [illegible] from other countries, [illegible] from Japan which are [illegible] to our American climate. [illegible] as well as our native plants, can [illegible] from our American nurseries, [illegible] they have had the care necessary for successful transplanting.

FLOWERS

Most of the flowers treated in this work will be found catalogued in this section, and not as generally treated in the alphabetical order of names scattered through the work. The Standard Dictionary gives the following definition of "flower":

"Botanically, a flower may be regarded as a sporangia (spore-case) bearing shoot or sporophore. Only two parts are essential, the androecium (male part) and the gynoecium (female part), these organs being necessary to the production of seed. But not all seed-bearing plants produce flowers in the popular meaning of the term, the conifers and their allies being considered flowerless. As ordinarily used, the term flower refers to those floral structures whose sporangia-bearing leaves are made conspicuous and are protected by colored leaves. Even when the sporangial leaves are absent (as hydrangeas and chrysanthemums) the clusters of colored leaves are called flowers. A flower in its simplest form may consist of only an axis that bears a single sporophyl. The opposite extreme may be seen in certain composites and orchids that possess complex and highly specialized floral structures, the differentiations having arisen apparently to aid the more easy transfer of pollen or the more effective scattering of seeds. A completely developed flower consists of a central short stem (torus), floral leaves (sepals,

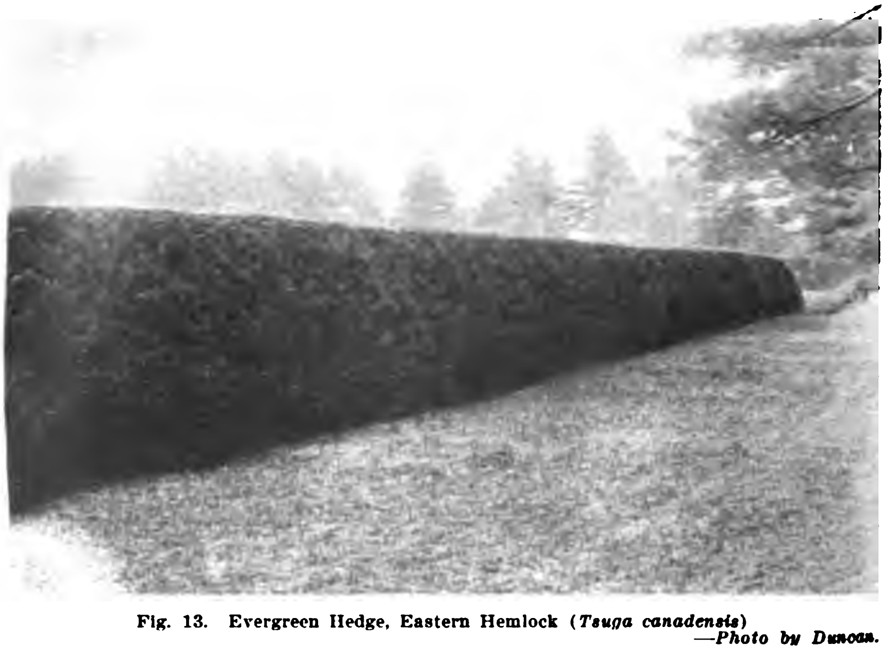

Fig. 13. Evergreen Hedge, Eastern Hemlock (*Tsuga canadensis*)
—*Photo by Duncan.*

petals), and sporangial leaves (stamens, carpels). These parts vary in number in different plants. True flowers are produced only by the higher vegetable organisms. Double flowers are developed by increasing the floral leaves at the expense of the sporangial ones, as the snowball."

Floriculture was not an important industry until about 100 years ago. Previous to that there was not a comparatively great effort to beautify the homes or to make floriculture an important commercial industry. This probably grew out of a number of facts. First, when people are struggling for subsistence and the struggle is severe, they have little time to devote to beautifying their homes, and the energy of life is directed toward obtaining those things that are necessary in order to live. Second, when society in general has accumulated but little money and there are few wealthy people, not much money can be invested in flowers or luxuries of any kind. Third, under these conditions society would lack that cultivated taste which would lead it to devote what energy it could to the culture of flowers. With the growth of education, with aesthetic culture and with the accumulations of money, which may be diverted from the necessaries of life to the luxuries, flower culture has become an important industry upon which millions of dollars are realized every year.

GRANVILLE LOWTHER

Roses for Central Washington

The following list of roses which do well in the Yakima Valley was compiled by Mr. Burton O. Lum, of North Yakima:*

Dark Red Roses—Etoil de France, H. T.; Louise Van Houtte, H. P.; Sultan of Zanzibar, H. P.; Prince Camile de Rohan, H. P.; Baron de Bonstetten, H. P.; Reine Marie Henriette, H. P.; Ulrich Brunner, H. P.; Gruss au Teplitz, H. T.; Princess de Sagen, H. T.; Avoca, H. T.; Jubilee, H. P.; Fischer Holmes, H. P.

Light Red Roses—Duke of Teck, H. P.; General Jacqueminot, H. P.; Richmond, H. T.; Papa Gontier, T.; Liberty, H. T.; Madame Battersea, H. T.; Captain Haywood, H. P.; Duke of Edinburgh, H. P.; Suzanne Marie de Rodocanachi, H. P. There are many other red roses that grow well in Yakima, but all of the above have been easily grown by the writer.

Pink Roses (including roses tinted with pink)—Antoine Rivoire, H. T.; Clara Watson, H. T.; Madame Carline Testout, H. T.; Magna Charta, H. P.; Paul Neyron, H. P.; Rosalind Orr, H. T.; Belle Siebrecht, H. T.; Madame Jules Grolez, T.; Prince de Bulgarie, H. T.; Maman Cochet, H. T.; Dean Hole, H. T.; Betty, H. T.; Duchess de Brabant, T.; Mrs. R. S. Sherman-Crawford, H. T.; Viscount Folkestone, T.; Anna de Diesbach, H. P.; Madame Gabriel Luizet, H. P.; Baron de Rothschild, H. P.; Jonkherr Mock, H. T.; La Tosca, H. T. These pink roses are especially adapted to Yakima.

Light Yellow Roses—Marie Van Houtte, T.; Amateur Teyssier, H. T.; Safronà, T.; F. Diegin, H. T.; Madame Pernet Ducher; Mlle. H. Cambier, T.; Chromatella, N.; Marechal Niel, N.; Sunset, T.

Dark Yellow Roses—Le Progres, H. T.; Harry Kirk, H. T.; Doctor Grill, T.; Madame Ravary, H. T.; Francisca Kruger, T.; Mrs. Aaron Ward, H. T.; Duchess of Wellington, H. T.; Madame Melanie Soupert, H. T.; Madame Hector Leuillot, H. T.; Melody, H. T.; Isabella Sprunt, T.; Sunburst, H. T.

The Hybrid Perpetuals, or H. P.'s, are quite hardy and hold their color better than the Hybrid Teas, or H. T.'s. The Teas must be protected in winter. All yellow roses do better in Yakima if they are in the shade part of the day.

White Roses—Frau Karl Druski, H. P.; Kaiserin, H. T.; Souv. Pres. Carnot, H. T.; Margaret Dickson, H. P.; White Maman Cochet, T.; Hon. Edith Gifford, T.; Ivory, H. T.

Neither the American Beauty, nor any of the La France roses, are included in these lists, as they do not grow well in Yakima. The buds blight with the exception of a few blooms in the late fall.

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* Abbreviations: H. T., Hybrid Tea; H. P., Hybrid Perpetual; T., Tea; N., Noisette.

Flowers and Plants in the United States 1899 and 1909

	Acreage	Value
1899	9,807	$18,758,864
1909	18,248	34,872,829

The Cultivation and Uses of Annual Flowering Plants

Ageratum

"For strengthening the garden's color forces in blue, no annual is so good as the ageratum." Though ordinarily used in bedding and borders in contrast with such plants as geraniums, perillas, amaranthus, etc., the rose, white, and blue ageratums are exceedingly attractive when mingled with alyssum, candytuft, and similar plants. They grow well upon almost all soils and through a wide range of climate; for that reason many combinations with them are possible. The plants are neat, bushy, and erect, with a continual profuse clustering of pretty brushlike flowers throughout the season. The dwarf blue sorts make fine borders and are much used where contrasting color effects are desired. For early bloom the seed should be sown in cold frames or in boxes in the house early in the season—March—but for summer and fall bloom the seeds may be sown in well prepared beds in the open. Seeds sown in August will produce good plants for winter flowering.

ALTHAEA ROSEA. See *Hollyhock.*

Alyssum

For borders, edgings, baskets, pots, rockwork, and for cutting, a liberal use of this dainty little flower is recommended. For borders, the seed should be sown thickly so as to form masses. For winter bloom, sow late in August and thin the seedlings so as to stand about four inches apart, but for spring bloom or for borders the seeds should be sown in the open early in the spring, or even late in the preceding autumn in some localities. Where the plant will not endure the winter, however, early spring planting under cover, either in a cold frame or spent hotbed, or in boxes in a dwelling, is most to be relied upon. Alyssum can also be increased from cuttings made from strong new side shoots, as well as by division of the roots. By cutting back after the first flowers fade others will be produced. While white is the most common and popular color, there are yellow varieties of alyssum.

ANTIRRHINUM. See *Snapdragon.*

AQUILEGIA. See *Columbine.*

Aster

The aster is certainly one of the most satisfactory of the annual flowering plants. The great variety in its size, color, form, and season of blooming makes it a most satisfactory plant for supplying cut flowers. In fact, many of the improved sorts produce flowers equal in form and size to some of the better sorts of chrysanthemums. The range of color presented in this group is one of its chief merits. Strange as it may appear, the plant world is not very well supplied with blue flowers possessing characters which render them suited to domestic or commercial uses. In the aster, however, are found many shades of blue and purple and for this reason, if for no other, the aster should prove an attractive decorative plant. The habit of growth adapts the aster not only to close planting for cut bloom, but some forms are robust, tall-growing plants, well adapted for use in an herbaceous border where late bloom and careless effects are desired. The more compact-growing, large-flowered forms are most desirable for cut blooms, while the tall-growing, open types are most useful in wild gardens or for screens. The wild aster (*Aster novae angliae*) is one of the most beautiful and most satisfactory of this latter class. The vigor and ease of culture of the aster are factors which contribute to its popularity.

Plants from seed sown in the open ground in May bloom finely in September and October, when the flowers are seen at their best. For July and August bloom, seeds should be sown in March or April in a cold frame, spent hotbed, or in pots or boxes in a living room. Cover the seeds about half an inch deep with rich, light soil and when the plants have three or four leaves transfer them to thumb pots or to other boxes, setting the plants about two inches apart each way. After all danger of frost is past transplant the plants so treated to their permanent home, where they should stand about 18 inches apart each way in well prepared beds. Fresh manure or manure used in too large quantities sometimes proves injurious to asters. Only thoroughly composted manure mixed with the soil is safe for these plants. Small quantities of air-slaked lime, or of fresh wood ashes, stirred into the surface of the aster beds prove beneficial to the plants. When given plenty of water and rich, fine soil asters can be grown into beautiful pot plants.

In some localities and during some seasons the aster is seriously attacked by the so-called black potato beetle or blister beetle (*Epicauta pennsylvanica*), an insect which feeds upon the partly developed buds, causing them to develop, if at all, into deformed, irregular blossoms. In such localities asters can be successfully grown under screens of mosquito netting or other thin cloth.

BACHELOR'S BUTTONS. See *Coreopsis*.

Balsam

Impatiens balsamina

A native of India, the garden balsam loves a hot sun, rich soil, and plenty of water. The young plants are quick, sure growers, and from seed sown in the open ground in May soon form handsome bushes thickly massed with large, rose-like flowers. Transplanting two or three times has a tendency to dwarf the plants into better shape and to make the flowers more double. Balsams are not often given room for perfect development; they will easily cover 12 to 18 inches of space each way. For the finest flowers choice seed is more than usually essential, for cultivation and selection have wrought wonders with this plant. The one objection to the balsam is its habit of producing its flowers, as it were, on the underside of the leaves, or inside the plant. While the individual flowers are beautiful, the obscure manner in which they are borne detracts considerably from the value of the plants. When used at the margin of groups or to crown a terrace they are shown at best advantage.

For early bloom the seeds should be sown about the middle of March in a gentle hotbed or in the dwelling house. As soon as the first true leaves have developed the young plants should be transplanted to thumb pots or to boxes where they will stand about two inches apart each way. An abundance of light and water is at all times necessary for success with these plants. Care should be exercised to prevent them from becoming drawn, as stocky, symmetrical plants produce the best flowers.

Calendula or Pot Marigold

The calendula or pot marigold is a hardy annual about a foot high. A moderately rich, light soil is most congenial to these plants, which should be placed about 8 or 10 inches apart, if planted in mass or in borders. The seed may be sown in the open ground quite early in spring, and the plants will be in bloom early in summer and continue to bloom until late in the autumn. The coloring of the flowers ranges through all shades of yellow from ivory to deep orange. The plants bloom freely and earlier than the marigold, and are useful in beds, borders, or backgrounds. The dried flowers are sometimes used for flavoring soups and stews. There are both single and double forms of the pot marigold. One of the most satisfactory methods of propagating this plant is from seeds sown about April 1 in the North in spent hotbeds or cold frames. After the middle of May, in localities north of Washington it will be safe to transfer the young plants to their permanent summer quarters.

California Poppy

Eschscholtzia

The eschscholtzia is the state flower of California, and an annual of striking character both as regards the form and color of its flowers, which are bright and rich in their tints of yellow and orange. The plants average about a foot in height, have attractive silvery foliage, and produce their large poppy-like flowers quite lavishly from early spring until frost. They are most effective when grown in beds of considerable size, over which the seed may be thinly sown broadcast and lightly raked in. These sowings may be made early in spring, or late in autumn for earlier germination and bloom the next spring. The eschscholtzia is also very useful as a pot plant and for cut flowers.

Calliopsis, Coreopsis

Coreopsis is a genus of showy annual or perennial herbaceous plants, with graceful long-stemmed flowers well suited for bouquets. The hardy annuals of this genus are generally known by the name calliopsis. This is one of the garden's great forces in yellows, strengthened with rich maroons and browns. Seeds of the calliopsis for summer flowering in situations north of New York city should be sown in March in boxes in a living room or in a gentle heat in a greenhouse or hotbed. In localities south of New York the seeds may be sown in the open in May in good garden soil, with the hope of an abundance of flowers from August until frost. The plants should be thinned or transplanted to at least 10 inches apart each way. Their tall, slender habit makes neat staking and tying necessary. All are fine for cutting, especially *Coreopsis grandiflora* and *C. lanceolata.*

Campanula
Canterbury Bells, Bell Flower
Slipperwort

Campanula is a genus comprising both perennial, biennial, and annual flowering plants. These fine old plants are rich in color, profuse in bloom, and of easy culture. For outdoor effects, when planted in quantity, they are glorious, and finest full-blown specimens of such varieties as *calycanthema* or Canterbury bells can be transplanted to pots for house decoration by soaking the soil about them with water and lifting with a ball of earth. The seeds of the annuals should be sown in April or early in May. The seeds of biennials should be sown outdoors early in July, and the plants may be thinned or transplanted to temporary quarters as late as October.

The old practice of covering Canterbury bells with leaves through the winter is not satisfactory. Transplant them six or eight inches apart in a cold frame, where they will make large plants by spring and are as easily cared for as pansies. In the spring set them 18 to 20 inches apart in beds where they are to bloom. In June and July they flower most profusely, and are in fine form a long time. They also make beautiful pot plants for Easter. If sown early in good soil the hardy perennials will bloom early the next year. All varieties like a rich, sandy soil, with good drainage.

Candytuft
Iberis

The candytufts are among the best white flowers for edging beds, for planting in belts, beds, or massing, for rockeries, and for cutting. Several of the varieties are fragrant, and all are profuse bloomers. The seeds should be sown outdoors in April where the plants are to bloom, and well thinned when they have grown about an inch high. Make a second planting a month later, and a third late in July for fall flowers. September sowings will give winter blooming plants. The soil for best results should be rich, and the plants given an abundance of water. They branch freely, and if some are removed the flowers will be larger.

CANTERBURY BELLS. See *Campanula.*

CARNATION. See *Pinks.*

Castor Bean
Ricinus

The castor oil plant, commonly spoken of as the castor bean, is especially valuable because it is one of the few annuals which can be used to produce a semi-tropical effect. Its rapid growth and large size make it valuable as the central object in groups where rich, luxuriant growth is required. The variety of color in the foliage of the different sorts of castor bean is of value in giving contrast, and when used in combination with cannas, caladiums, coleus, or scarlet sage most striking effects of contrast can be produced. As a background for lower growing plants the castor bean has no equal among garden annuals. Only the annual climbing vines, when provided with suitable supports, equal it as a low screen. It can be used with good effect in groups, as masses along shrubbery borders, or as belts for covering and shutting out an undesirable view.

At the North, the castor bean is most satisfactory when started in March or early in April in a gentle heat. A hotbed, greenhouse, or living room can be made use of for the purpose. As soon as the first true leaves have formed, the young plants should be pricked out into small boxes or pots, where they should be kept growing slowly until all danger of frost has passed, when they may be transferred to the open. After transplanting the young plants, it is desirable that they have sufficient room to prevent them from growing too tall and consequently from losing their lower leaves.

If planted in the open ground at the same time garden beans are planted, the castor bean will make a growth of from four to six feet by the middle of August. This plant loves a rich soil, plenty of moisture, full sunlight, and great heat. The varieties range in height from 3 to 10 feet and have leaves of corresponding size.

CENTAUREA. See *Corn Flower*.

Chrysanthemums

The chrysanthemums, like the pinks, contain some of the most valuable of the commercial florists' products, both hardy perennial and annual flowering plants.

The large flowered types of chrysanthemums, which each autumn produce such gorgeous shows in the stores, florists' establishments, and conservatories, are not hardy, and since they are treated as greenhouse plants by the florists they are only mentioned in this list. The class of hardy chrysanthemums, which should be more commonly seen in every flower garden, and which are known as pompons, are simply noted to give proper relation to the annual chrysanthemums which are the subject of this sketch.

These plants bloom most satisfactorily if the seeds are sown early in a hotbed or cold frame and the young plants transferred to the open as soon as the soil has become sufficiently warm to keep them growing without check. If started in a hotbed the young plants should stand 10 to 12 inches apart when set in their permanent locations. Somewhat less satisfactory results can be secured by sowing the seed about corn planting time in the open where the plants are to bloom. The seedlings should be thinned to stand at least eight inches apart. If the same care in regard to disbudding and pinching back is taken with the annual plants as with the large flowered perennials the work will be rewarded by greatly increased size of the flowers.

Clarkia

The clarkia is one of the prettiest hardy native annuals of the Inland Empire. It blooms freely, which characteristic, taken in connection with the variety and brightness of its flowers, makes a bed of them in full bloom an attractive sight. They are useful, too, for hanging baskets, for vases, as edging plants, for low massing, or for borders.

The seeds should be sown outdoors in early spring and the plants grown in partial shade. The clarkias thrive in a warm, light soil, and their period of bloom is midsummer and late autumn. The average height of the plant is 1½ feet.

Cobaea Scandens

Cobaea scandens is a rapid growing, climbing vine which is easily propagated from seed. The dark color and refined character of its foliage, together with its bell shaped flowers, render it a very satisfactory vine for covering broad areas. It is a less rampant grower than the moonflower, but furnishes quite as satisfactory a screen made up of much finer leaves. The flowers are not conspicuous, because of their modest colors and because they are hidden by the foliage. Their form, however, is pleasing and they are open during the day.

When the young seedlings have developed their first true leaves they should be transferred to three inch pots or to tomato cans and kept growing slowly until danger of frost is past. In the open, a rich border should be provided, for as soon as hot weather comes on the plants grow very rapidly if ample food is at their command. A rabbit netting trellis or support is more satisfactory than cords or smooth wire for this plant, as it fastens itself chiefly by tendrils rather than by twining, as does the morning glory.

Cockscomb

Celosia crista

The cockscomb are prized and planted as an odd and picturesque decorative feature of the garden. The dwarf varieties make novel and attractive borders; the tall ones form striking groups, and when interspersed with other lower growing plants in a border they produce a pleasing contrast. There are both red and yellow forms of the cockscomb, but the bright red and crimson varieties are most effective in gardens and also in winter bouquets, for which they are cut before fully ripe and dried in the house. The young plants can be grown from seeds sown in gentle heat in April and transplanted to the open ground the middle or last of May, or the seeds may be sown early in May in the open where the plants are to stand. Transplanting into rich soils about the time the combs begin to form makes the flower heads much larger. They are bright from midsummer until frost.

Columbine

Aquilegia

The columbine is a hardy perennial, with many horticultural varieties, and is a desirable border plant. Its habit of growth is to form large clumps. It blooms profusely early in the season and remains in bloom for a considerable period. It is quite hardy, and is useful for cutting. The peculiar pendant flowers are interesting in themselves because of their unusual form, and this feature, taken in connection with the graceful habit of the plant, gives each clump of columbine a striking and interesting appearance.

Sow the seed in the open ground in spring, preferably where the plants are to grow, and thin the young seedlings to about a foot apart. Seeds may also be sown in the autumn for flowering the following season. The plants thrive well under good garden culture, but such rare sorts as *Aquilegia coerulea* and *A. chrysantha* do best in partially shaded, well-drained nooks. Few hardy perennials are so easily grown from seed.

Coneflower

Rudbeckia

Many of the rudbeckias are hardy and perennial, but they may be treated as annuals. The flowers are quite showy and usually have yellow rays, though some are crimson and others more or less covered with brown toward the base. The rudbeckias are of very easy cultivation, thriving in almost any soil and climate. Most of them prefer a moist soil, but will thrive in the garden under ordinary cultivation. *Rudbeckia hirta*—the Blackeyed Susans, or "nigger-heads," as they are sometimes called—will thrive in the hottest and driest situations. *Rudbeckia triloba*, a biennial, perpetuates itself through self-sown plants. The *triloba* may be used quite effectively as a border to a large bed of delphiniums or as a screen, as it forms a dense bush between three and four feet high. The rudbeckias are propagated by means of seeds or cuttings, or by division. The Golden Glow, one of the most satisfactory plants of this group, is well adapted for planting in a shrubbery or herbaceous border. It grows to a height of from three to four feet, and may be used as a screen when lower growing plants are placed in the foreground.

COREOPSIS. See *Calliopsis*.

Corn Flower

Centaurea

Centaurea cyanus is also known as "blue bottle," "ragged sailor," "kaiser blumen," and sometimes as "bachelor's button." These bright flowered plants are of a hardy nature, requiring simple culture, yet they are among the most attractive and graceful of all the old fashioned flowers. When placed in water after cutting, the flowers increase in size. Seed of the annual sorts should be sown in the open in April or May and the young plants thinned to four to six inches apart. They thrive well on all moderately rich garden soils. The perennials may be grown from seeds sown in gentle heat in March and planted out in May or June.

Cosmos

Cosmos is now one of the notable fall flowers. It is a strong, tall growing annual, yet its bright, bold flowers have a daintiness and airiness which is heightened in effect by the feathery green foliage. It is most effective when planted in broad masses or long background borders against evergreens or fences at some distance from the house and the garden walks. From seed started in the house in March or April the plants will have reached three or four feet in height by September. The bright colored, daisy-like flowers are borne in great profusion and come at a season when they are very acceptable. Because of the robust habit of the plant the young seedlings should be thinned to 18 inches apart when grown on moderately good soil. Sowing the seed late and in poor soil will dwarf the plants. In the latitude of Washington, D. C., the plants perpetuate themselves from self-sown seed. These volunteer plants can be taken advantage of for early bloom.

CYPRESS VINE. See *Ipomoea.*

DELPHINIUM. See *Larkspur.*

DIANTHUS. See *Pinks.*

DIGITALIS. See *Foxglove.*

ESCHSCHOLTZIA. See *California Poppy.*

Cypress Vine

Ipomoea quamoclit

The cypress vine is very distinct both in foliage and flower from the moonflower and the morning glories. The flowers are small, star shaped, and usually pink in color; they are feather-like both in form and delicacy. The leaflets being fine, the general appearance of the plant is light and airy. While the plant does not grow as robustly as those named above, it is well adapted for covering low screens and arbors. It grows readily from seed, which should be sown in a rich border rather thickly, about corn planting time, and the young plants thinned to stand four to six inches apart in the row.

Evening Primrose

Godetia

The evening primroses are choice, free-blooming annuals, with widely opened flowers of satiny texture, with delicate colors. They are suited for solid beds, border lines, for pots, and to grow in shrubbery borders in shaded places, where few other flowers will flourish. The seed should be sown in an open border or in a cold frame in spring. If the latter, the seedlings should be transplanted to stand about a foot apart in rather thin or sandy soil. These plants are also successfully treated as biennials by sowing the seed in July and transplanting the young plants to a cold frame, to be placed in the open the following May. The blooming season is from early spring until frost, and the average height of the plants is 1½ feet.

Forget-Me-Not

Myosotis

The dainty little flowers commonly known as forget-me-nots are hardy perennials that love cool, moist soils, and, like pansies, bloom most freely in fall and early spring. They make a satisfactory close border, the beauty of which is heightened by abundant bloom. The forget-me-not is also satisfactory as a winter-blooming plant for growing in cool rooms or cold frames. Another feature characteristic of this plant is that, after once having been introduced into a garden, it perpetuates itself from year to year by self-seeding like the poppy, portulaca, and several of the other desirable annuals. Sow the seeds in spring in a warm, sunny border. Most varieties bloom freely the first season and profusely the second year. The average height of the plant is six inches.

Four-o'Clock

Mirabilis jalapa

The mirabilis, sometimes called the "Marvel of Peru," is normally a perennial in its native region, the warmer parts of America, but under garden culture it gives satisfactory results when treated as an annual. The seed may be sown in the early spring under glass and the plants set out in May. The four-o'clock is often used as a screen with good results. The colored part of the flower, which is white, various shades of red, and striped, is the calyx, drawn out in the semblance of a corolla and surrounded at the base by a leafy involucre. In some cases, as in *Mirabilis jalapa*, only one flower is borne on an involucre.

The plant is a quick growing, erect, bushy herb, attaining to a height of from two to three feet. Its blooming period is during the late summer and autumn. Because of its habit of opening its flowers only late in the afternoon and on cloudy days the popular name, four-o'clock, has been given. While this plant is a tender annual in the northern part of the United States, it frequently reproduces itself from self-sown seed, and even as far north as New York city it frequently manifests its perennial habit of developing tuberous roots sufficiently large to be lifted and stored like those of the canna.

Foxglove

Digitalis

The tall flower stems of the foxgloves are particularly attractive when seen growing among shrubbery or in bold masses along walks or drives. As a background for lower growing plants the foxgloves are also very useful and interesting. The spikes are frequently a foot or more in length and thickly strung with many showy, thimble-shaped flowers. Some of the new sorts rival gloxinias in shadings and markings.

Plants may be grown from seeds sown in the open in May and the seedlings transplanted where they are to grow in the open or, preferably, to a cold frame, where they make extra strong plants that will flower profusely the next season. They are most satisfactory when treated as biennials, sowing the seed every year in rich, deep soil and partial shade. The average height of the plants is from two to three feet. When the center spike begins to fade it should be cut out and the side shoots will, in consequence, grow more vigorously.

Gaillardia

In the gaillardias are found both annual and perennial plants offering a wide selection of varieties and a profusion of bloom over a long period. The blooming period begins early and continues late in autumn. They are well adapted to mixed borders and are very satisfactory as cut flowers. The stems are of good length, carry the flowers well, and keep fresh as cut flowers for a long time when placed in water.

The annual gaillardias are all propagated readily from seeds sown in the open, but earlier flowers will be secured by sowing seeds in a hotbed and transplanting the plants to the open as soon as killing frosts have passed. In either case the blooming plants should not stand closer than ten or twelve inches. They grow and bloom best when fully exposed to sun and air, and when planted on a fertile but light and well drained soil.

GODETIA. See *Evening Primrose.*

HELIANTHUS. See *Sunflower.*

Hollyhock

Althaea rosea

These too frequently neglected old-fashioned perennials are most pleasing and attractive when seen in groups or long rows against evergreen hedges or shrubbery as a background, and, in turn, form a very satisfactory background setting for plants of lower growth. The color variety in these plants is very great, ranging from pure white through almost every conceivable shade of yellow red, and rose to ashen-gray and almost black. Although hollyhocks are permanent and hardy, even during the first winter, it is advisable to make seed sowings every year, as the flowers on young, vigorous plants are much finer than those upon old ones. Seed sowings should be made in April or May, and not later than June, to flower the next year. In the final transplanting each seedling should be given a foot or more space each way to allow for full development. The average height of the hollyhock is four feet; many sorts, however, are much shorter, while an equal number are taller than the average above stated.

Ipomoea

Morning Glory, Moonflower and Cypress Vine

The plants included under the names morning glory, moonflower, and cypress vine, while all classed together botanically, are quite varied in form of flower and foliage. Their chief merit rests in the fact of their rapid growth and ability to cover large spaces in a short time. The shoots grow long and are well provided with foliage, two factors which adapt them well for temporary uses, such as covering structures and summerhouses, and for immediate effect upon new buildings. All three of the above named types grow readily from seed, the morning glory and cypress vine both giving good returns from seeds sown in rich borders about corn planting time. The moonflower can be propagated either from seeds sown in a hotbed about the first of March in the climate of Washington, or from cuttings carried over winter in a greenhouse. For best success with the Imperial Japanese morning glories and the moonflowers the seeds should be filed to make a slight aperture in the hard, horny covering, or they should be soaked for several hours in warm water. If these precautions are not observed a poor stand will usually be the result. Both these groups profit by being started in a hotbed or greenhouse in March or April, and are then transplanted to the open only after all danger of frost has passed.

Larkspur

Delphinium

Blue is a comparatively rare color among our cultivated plants, and for that reason the delphinium, which shows this color in great variety, is particularly valuable. The brilliant flower spikes can be seen from a distance and are strikingly effective in beds or masses, in borders, shrubberies, or in combinations with white lilies or other plants where a high contrast is desirable. The tall sorts should be planted among shrubbery or used as a background for other low growing plants whose bloom will produce a pleasing contrast with the larkspur. The dwarf types are better suited for bedding and for low borders. Improvements are continually being made in the size of the flowers, as well as in the length and fullness of the spikes. Some of the species flower both early and late, and the season for all can be prolonged by care in cutting away withered flower stems as fast as they appear. The delphinium is sometimes increased by division, but like most other plants they are more robust when grown from seed. This plant is easily propagated and adapts itself to many conditions, but in a soil deeply dug and well enriched with fine old manure their blooms are largest and best. For best results the plants must have ample room to grow; 1½ to 2 feet each way is not too much for the taller sorts.

Annual Varieties

These include the rocket and hyacinth-flowered larkspurs, so called from their long, narrow flower spikes. They bloom best in a rather cool, moist soil. The seed may be sown in the open border, either in spring or fall, preferably the latter, so that germination may take place very early in spring. As the seedlings grow, thin them to stand 6 to 18 inches apart, according to variety. The shades of color include light, dark, and azure blue, white, buff, rose, apple blossom, pink, brick red, red lilac, dark lilac, violet, and fawn. The varieties are seldom kept separate, as they are quite as pretty and convenient for cutting when sown in mixture. Some of these are really hardy biennials, but because they bloom the first season they are treated as hardy annuals.

Perennial Varieties

These are usually taller than the annuals, requiring more space between the plants. If sown in the autumn or very early in spring many will bloom the first season. The foliage is clean and attractive and the habit of growth strong, producing long flower spikes.

Lobelia

The Erinus varieties (lobelias) are charming little plants that bloom very quickly from the seed and continue gay with flowers all through the season. For beds, edgings, baskets, and pots there is nothing prettier; their clear colors and generous bloom make them welcome anywhere.

The seeds may be sown outdoors in early spring where the plants are to grow. As the plants appear they should be thinned moderately, or transplanted several inches apart in rich, open soil. Liquid manure given while they are in bloom greatly improves the flowers. Many sorts are also good winter conservatory plants of trailing habit. The perennial or tall varieties are handsome, showy plants, found quite effective for backgrounds and grouping.

Marigold

Tagetes

There are two distinct types of garden marigolds, each with numerous horticultural varieties, derived from two distinct species.

The French marigold, which is the most compact and regular in growth, and consequently the most valuable as a bedding or a border plant, has been developed from *Tagetes patula*, while the African marigold, which is of a more spreading and open habit of growth and therefore less suited for bedding purposes, but well adapted for herbaceous or shrubbery borders, has been developed from *Tagetes erecta*. The common names of these plants give no clew to their nativity, both being tropical American plants, in spite of common names to the contrary.

The French marigolds are all useful bedding plants. The habit of growth is erect and compact, with good foliage. The flowers are well formed, bright in color, and occur from June until frost. While these plants can be grown and successfully brought into bloom from seeds sown in the open in April in the latitude of Washington, such plants do not give as early bloom or the profusion of bloom which will be borne by plants started in a house and shifted for a time into pots which confine the roots of the plant and check it, so that when set in the open the increased food supply has a tendency to induce the development of flowers rather than wood, a tendency which is maintained, much to the gratification of the gardener, throughout the season. When transferred to the open the plants should be set at least a foot apart each way. The same distance should also be given plants grown from seed sown in the open. There are both double and single forms of the French marigold. The named varieties are especially good, but very satisfactory results are obtained from mixed seeds.

The African marigolds frequently grow two or more feet in height, and for this reason are better suited for planting in mixed borders or along belts of trees and shrubs than in beds or masses in small areas. This is, however, the common marigold of the garden in America. The leaves and flowers are strong scented. The range of color in the flowers of this type of marigold is from sulphur yellow to orange, the darker shades being more commonly met with than the lighter ones.

Mignonette

Reseda

Every indoor or outdoor garden must have mignonette in plentiful supply. The seed can be sown at any time, and if successive plantings are made, its fragrant, modest colored flowers may be gathered outdoors until November. For early bloom in the open, sow seed in pots or boxes under glass in February or March and thin or pot off the seedlings, to make stocky plants for bedding out, as soon as severe frosts are past. To insure a succession of bloom throughout the season, sow a row or two at a time in the open about April 15 in the vicinity of New York, and earlier southward, repeating regularly at intervals of about three weeks till August. The July sowing will make good winter flowering plants. The average height of mignonette is one foot.

MOONFLOWER. See *Ipomoea*.

MORNING GLORY. See *Ipomoea*.

Morning Glory

The Imperial morning glory is the most varied and most beautiful of the group. One of its interesting features is the variety of its flowers and leaves. The latter differ greatly in shape, as well as in size; some are plain green, while others are oddly marbled and blotched with white or yellow. The colors and markings of the flowers vary from pure white to rose, crimson, and carmine through blues and purples of every shade to almost black. There are velvety single self-colors, a few doubles and semi-doubles, others with quilled or feathered petals, many fancifully bordered, blotched, striped, penciled, and marbled—hardly any two plants from a seed packet seeming alike. The vines are vigorous, growing rapidly to a height of 30 or 40 feet. In sowing or planting they should be allowed about twice as much space as the ordinary morning glory, and in the open should not be sown quite as early in the year.

Moonflower

Ipomoea bona-nox

The moonflowers are the most vigorous in growth of any subdivisions of the genus included in the above list. The leaves are large, frequently five or six inches across, and the large white flowers, which open soon after sundown, are frequently four to six inches across. These plants with good soil conditions and plenty of moisture will make a growth of from 40 to 50 feet during the season.

Nasturtiums

A wide range of colors has been developed in this favorite flower, the nasturtium, which for three or four months of the season makes a better display than almost any other plant. No other annual will produce such a profusion of flowers for so long a time with the same outlay of time and labor. The maximum of bloom is produced on thin soils, and the plant never flags through the hottest weather; in fact, too much rain or moisture greatly reduces the supply of flowers. In soils too rich the leaves predominate and the plants are apt to rot off in wet weather, especially if standing too close. The seeds should be planted an inch deep, and the seedlings thinned to 10 or 12 inches apart. The rows for bedding varieties should not be less than a foot apart, and for tall varieties four feet.

Dwarf or Tom Thumb Nasturtiums

Tropaeolum minus

These plants have a neat, compact habit of growth and attractive foliage, and are not infested by insects. Blossoms appear in two months from the date of seed sowing, and continue throughout the whole season. A bed of dwarf nasturtiums in full bloom is a sea of color. It is said that a good bed, 6 by 20 feet in size, will yield about 1,000 flowers per day. The average height of the dwarf variety is nine inches.

Tall or Climbing Nasturtiums

Tropaeolum majus

Besides their ordinary garden use for trailing over fences, trellises, stone walls, etc., the climbing nasturtiums can also be grown as pot plants for winter-flowering as screens, or as trailers for hanging baskets and vases. Sow plenty of seed in drills, and thin to six inches apart in the row. Like the dwarf forms, these plants bloom most quickly and profusely in poor soil. Their flowers are usually a little larger than those of the dwarf sorts. The average height of the plant is five feet.

Nemophila

The representatives of the genus Nemophila are dwarf, compact growing, hardy, annual herbs, which produce an abundance of showy bell-shaped flowers from early spring to late autumn, for which reason they are esteemed for borders and for bedding purposes. All the species may be propagated from seed. If the seeds are sown in the open about the middle of August and then transplanted in late autumn very early flowers may be obtained. For summer and late fall blooms the seed may be sown in the open in April and not transplanted. The nemophilas love a moist loam, with partial shade, and produce an abundance of showy flowers, which are very valuable for bedding and for cut flowers. The whole plant is more or less hairy.

Pansy

Viola tricolor

The pansy, sometimes called heart's-ease, is a favorite with almost everyone. It is a plant that demands more than ordinary attention, but none repays such attention more liberally. For very early outdoor bedding the seed is sown in the autumn—September—in a cold frame, or in rich, moist garden beds, from which the plants can be transferred to a cold frame, setting them two or three inches apart each way before severe winter weather begins. In spring three-fourths of them can be lifted out for bedding, and the rest left to bloom in the frame. For winter bloom in a frame, set the plants about twice as far apart, and thin out half of them in spring. Cover the blooming plants with sash, adding a covering of matting or straw in very cold weather. In mild weather remove the mats and lift the sashes to admit light and fresh air and to prevent the plants from becoming drawn. In outdoor beds raised a few inches above the ground, with a mulch of dry leaves and some brush to hold them in place, pansies will often winter nicely and bloom until midsummer, when a relay of young, vigorous plants should be ready to replace them.

Spring sowings should be made early, so as to secure good flowers during the early rains. Seed sown in a cool, moist place in June and July, and well tended, will give good flowering plants for fall. If they come into bloom in the heat of summer the flowers may be small at first, but as the weather becomes cooler they will increase in size and beauty. Through summer heat the flowers are finer in a somewhat shaded place, but in almost any situation good pansy seed will give fine flowers in spring and fall. Early fall sowings give the finest spring flowers.

Petunia

Because of the ease and facility with which all of the single-flowered varieties of the petunia can be grown from seed this plant commands attention as a worthy candidate for the summer flower garden. The young plants grow rapidly and come into bloom early, and in addition to this they furnish a continuous wealth of blossoms until destroyed by frost. The large-flowered strains are very beautiful and of great variety. While the single sorts are common and inexpensive, the double giant-flowered varieties are rendered expensive because they must be reproduced from seed which sets only after careful hand pollination of the flowers, which is in itself an expensive operation, or from cuttings, of which an individual plant can supply but a limited number.

For best results the seeds of all sorts should be sown in a gentle hotbed, cold frame, or in fine soil in a box placed in a sunny window in March or early in April for localities north of Washington, D. C. When the soil has warmed sufficiently and the danger of frost has passed, the seedling plants should be transplanted to a rich garden loam and placed about a foot apart each way. The seed of the double varieties is less vigorous than that of the single sorts and therefore requires more attention to prevent extremes of temperature and of moisture to insure good germination. If the seeds are sown in boxes in the living room, a pane of glass may with advantage be kept over the top to maintain a close atmosphere, and thus prevent the loss of moisture until the young plants are well out of the ground. In planting, the seeds should be scattered over the surface of the soil and brought in contact with it by firming. They should not, like most other seeds, be covered.

Petunias are attractive in beds and masses, serve well for broad borders or bands and thrive well in window boxes. They are not exacting as regards soil conditions, thriving well in almost any arable soil, and they endure drought well and bloom profusely.

Phlox

Phlox drummondii

The annual phlox, sometimes called flame flower, is particularly useful and attractive when sown in masses or ribbon beds of contrasting colors. Few annual plants are more easily grown from seed, give a quicker return of bloom, or offer such a variety to choose from as do the phloxes. There are few desirable colors beyond their range, and if given good soil and plenty of water they furnish a supply of delicate flowers for cutting throughout the season. The phloxes are also useful as window garden plants, and may be used as an undergrowth for tall, bare-stemmed plants. The first sowing of seed should be made as soon as the frost is out of the ground in the spring; later ones in May, either where the plants are to bloom or in a seed bed, as the phlox transplants readily. In transplanting set the taller kinds about a foot apart; if planted too thickly they suffer from mildew. The removal of flowers and seedpods makes the plants more bushy and compact and lengthens their blooming period. The average height of the plant is about a foot.

Pinks

Dianthus

The large and varied genus of Dianthus contains some of our most beautiful and most profitable flowers. The most of them are hardy perennials that bloom freely the first season, the plants remaining green all winter and blossoming the next year also if lightly protected by a mulch of straw, cut fodder, or leaves. Old plants flower the earliest, but as young ones give the largest, finest flowers, sowings are made every year. Seed can be sown under glass or in an open sheltered bed in March. The seedlings are easily transplanted and should stand 8 to 12 inches apart; dwarf ones, about six inches. If especially large brilliant flowers are desired, a bed of well mixed turfy loam, leaf mold, and well decayed manure should be prepared for them. Good drainage should be provided, as the plants are impatient of too much moisture and are more liable to winter-kill in moist than in well drained situations. In fact, the plant is hardy to severe cold, but succumbs when exposed to low temperatures in wet places.

The Carnation Pink

Dianthus caryophyllus

This plant, which is the forcing carnation of the American florist, can be grown from seeds sown early in the season in hotbeds, the young plants being given frequent shifts to pots of increased size as they grow until all danger of frost is past and the growing season is well on, when they may be transferred to the border where they are to bloom. If they are given a rich soil and an abundance of moisture, the bloom will more than repay the extra trouble taken. Seedling plants are more variable in character than plants propagated from cuttings, and for that reason are not well suited for commercial purposes.

On the continent of Europe this type of dianthus is more commonly used as a garden annual than in America. The form known as "Marguerite carnation," which has recently come into popular favor, is well adapted to cultivation as an annual. The majority of its flowers come double, and it has a pleasing habit of growth.

Poppy

Papaver

In the spring, even before the tulips are fairly gone, old gardens begin to be gay with poppies, which, in some one or other of their many forms, continue a procession of bright blooms until frost. No other plants possess so bold and brilliant a flower, coupled with the same grace of stem, airiness of poise and delicacy of tissue as the poppy. For beds and borders, with a background of green, there is nothing which will produce a more striking contrast. Some sorts are admirable for naturalizing in open wooded grounds; others, like the Shirley, are beautiful for cutting. A sandy loam suits poppies best, and as their strong tap roots are difficult to transplant it is well to sow seeds where the plants are to bloom. Seed sowings made in the autumn and at intervals in spring will provide a long succession of flowers. The seeds should be sown thinly and covered very lightly, as the seed is quite small. As soon as the young seedlings are well established thin the plants to stand about a foot apart. The plants which bloom most profusely are those grown from fall or early spring sowings while the earth is cool and moist.

Portulaca

This bright flowered, thick leaved annual (portulaca) is unrivaled for brilliancy among plants of low growth. It possesses the ability to flourish under extremely adverse conditions; even the hot sun and a light sandy soil, with sparse water supply, will not destroy it. It is satisfactory for beds, edgings, and rockwork, and for filling up irregular spaces or unexpected gaps in flower beds. As an undergrowth for taller plants it is also valuable. It flourishes, carpeting the ground with a mat of succulent foliage that in the forenoon is hidden by the gayest flowers. The plant is particularly useful in the Northwest. The seed does not germinate until hot weather, and should be sown late. Beyond the sowing, this plant requires little care. The hardy character of the plant is shown by the fact that it can be transplanted while in full flower through the driest, hottest seasons. The average height of the portulaca is six inches.

At Washington and southward this plant will perpetuate itself by self-sown seeds. In some soils this is sufficient to cause the plant to assume a weedy character. It never becomes troublesome like its near relative, the weedy garden purslane, or "pusley" (*Portulaca obracea*).

POT MARIGOLD. See *Calendula.*

RICINUS. See *Castor Bean.*

RUDBECKIA. See *Cone-Flower.*

SALVIA. See *Scarlet Sage.*

Scarlet Sage
Salvia splendens

The scarlet sage is a standard bedding plant that keeps the garden bright with color until late in autumn. This plant lends itself to many uses; it makes a good pot plant, does well in window boxes, and is useful for cutting to give color. Its best use, however, is as a hedge or border plant where long broad bands of intense color are desirable.

In the climate of Washington, D. C., seeds should be sown in window boxes or frames in March or April and the plants set outdoors during the latter part of May, or the seed may be sown outdoors after the first of June if protected from heavy rains and strong winds. The plants grow and bloom profusely in any light, rich soil. Both the tender and hardy perennial sorts bloom the first year and all are treated as annuals.

SCOTCH PINK. See *Pinks.*

Snapdragon
Antirrhinum

The snapdragon is a valuable border plant. It flowers the first year from seed sown as an annual. The bright color and peculiar form of the flowers always attract attention. The newer sorts offer variety of colors and of markings. The spikes are useful for cutting and keep fresh a long time. From seed sown in the open ground in May plants will bloom in July and August. For early flowers the seed should be sown under glass in February or March and transplanted into beds of warm, dry soil moderately enriched. If protected by a cold frame or even a mulch of leaves, the plants will winter well and bloom early the following year. The snapdragon, like most perennials and biennials which bloom the first year, and of which a particular display is desired, should be treated like an annual and sown every year. The plant blooms freely and continually until frost, its average height being one and one-half feet.

Stocks
Matthiola

The group of plants known as stocks offers many desirable qualities. The plants are vigorous, have a good habit of growth, fragrant flowers in various colors, a long season of bloom, and are adapted to a wide range of cultural conditions. Stocks are suitable for bedding, edgings, pot culture, house or conservatory use, and for cutting. For bouquets and floral work the double white sorts are especially useful. To secure early flowers, seeds should be sown under glass in March or April, and the young seedlings transplanted when an inch high into other pots or boxes, or into the fine soil of a spent hotbed. Advantage should be taken of showery May weather to transfer the plants to garden beds or deep, rich soil, setting them about a foot apart each way. As with other plants, frequent transplantings during the early stages of growth tend to give them a more dwarf and compact habit. For late flowers seed sowings may be made in the open ground in May. If plants that began to bloom late are carefully lifted and potted in the fall they will flower freely during the winter in a house or room that is tolerably cool and moist. The blossoms are very lasting. The average height of the stocks is from one to one and a half feet.

Sunflower
Helianthus

These tall growing, bright flowered annual plants have not received the attention they deserve. They have suffered the misfortune of having been cheapened by use as a burlesque. In reality, however, the tall growing, large flowered sorts, as well as the dwarf, many flowered varieties, are useful when skillfully employed in mixed plantations with other herbaceous annuals. The golden yellow disks are like sunbursts among the shrubbery. The tall habit of the plant and the dense foliage of some varieties suit them well for backgrounds and screens. Their long stems and extraordinary lasting qualities make them of value as cut flowers.

The seed should be planted in the open garden in spring, at about the same time that corn is planted, and the plants thinned to stand from two to four feet apart, according as the plant is dwarf or tall growing. There is wide variation in the height and habit of growth of the different varieties, which range from two to ten feet in height, with from one to many flowers.

Sweet Peas
Lathyrus odoratus

The sweet pea during the last decade has been greatly modified and improved by careful selection and cultivation, the flowers being larger and more varied in color and marking than formerly. The result is that the sweet pea has come to be one of the most popular annual flowering plants. It repays well the attention given it. The flowers are well suited for bouquets, and lend themselves well to table decoration. While the climbing habit of the plant is such as to prevent its use in groups and borders, its height is not sufficient to allow its use as a cover or screen for a lattice. The most satisfactory method of growing it is in long rows provided with rabbit netting wire, supported by strong anchor posts and intermediate stakes, to prevent the wire from sagging between its supports.

Sweet peas require a soil deeply tilled and well supplied with plant food. A satisfactory method is to open a trench about a foot wide and ten inches deep in rich garden loam, in the bottom of which about three inches of well rotted manure are placed, with two inches of fine top soil scattered immediately over it. Upon this bed sow the peas in double rows about eight inches apart, the seeds being placed from half an inch to an inch apart in the row. Cover the seed about three inches deep, and after the young plants appear and have attained sufficient height fill the trench completely.

As the sweet pea can hardly be placed in the soil too early in the spring, all general preparatory work should be done in the autumn, and the seeds sown as early in March as practicable. In sections with a winter temperature less severe than that of Washington the best results will undoubtedly be obtained from fall sowing.

Sweet William. See *Pinks*.

Sweet William
Dianthus barbatus

The sweet william, which is to be found in every grandmother's garden, is one of the most satisfactory members of this group for annual planting. While seed can be sown in the open early in the season, about corn planting time, the best results in the way of early bloom come from plants produced from seeds sown in a hotbed not later than the 10th of March in the latitude of New York, the young plants being pricked out into flats or, preferably, into thumb pots, and later shifted to three inch pots before planting in the flowering border. The outside planting of hotbed grown plants should be delayed until the season has advanced sufficiently to prevent the plants suffering from a check by cold after being placed in the open. The pot grown plants should be set at least ten inches apart and seedlings from seed sown in the open had best be thinned to stand at least eight inches apart.

The Scotch Pink, or Grass Pink

Dianthus plumarius

The Scotch pink is a hardy dianthus, which, when treated as an annual in like manner as the sweet william, gives very satisfactory results. The delicately fringed, variously colored, fragrant flowers give the plant an odd yet attractive appearance.

The flowers of all the plants of this group are most satisfactory for bouquets and table decoration because of the length of time they will keep in a fresh and attractive condition after being cut and placed in water.

Verbena

The verbena is a low growing annual, with a decumbent or creeping habit. The flowers are borne on terminal or lateral shoots, which lift themselves from five to seven inches off the ground, and when grown in mass the plants will form a mat which in full bloom will give the soil the appearance of having a carpet of flowers. Because of the ability of the plant to form a compact growth and produce a wealth of flowers over a long period, the verbena is frequently used as a bedding plant where carpet bedding effects are desired. The contrasting colors in the varieties which come true from seed allow of securing pleasing combinations of colors which are effective where low growing plants can be used. The length of stem and the texture of the flower are such that the verbena is of value for bouquets and table decorations. The verbena can be used with good effect in beds, borders, mounds, and in window boxes.

While the verbena grows readily from cuttings and from layers, seedling plants are more vigorous and as a rule produce better flowers. For the earliest bloom in the latitude of Washington, D. C., sow the seeds early in February in a moderately warm living room or greenhouse. For general outdoor planting the seeds may be sown about March 10, either in a living room, hotbed, or greenhouse. Soak the seed a few hours in tepid water and sow in seed boxes filled with light, rich soil; cover one-fourth of an inch deep, press down firmly, and water sparingly. When the seedlings are about an inch high transplant them into other boxes, placing the young plants two or three inches apart each way. If thumb pots are available use these in place of boxes. When planting out time arrives choose a bright, sunny situation. Make the soil rich and compact rather than light, but in all cases provide good drainage. Set the young plants 10 to 15 inches apart each way and give good cultivation until they cover the ground. With such treatment the verbena should give continuous bloom from early summer until killed by frost.

Zinnia (Youth-and-Old-Age)

The zinnia is easily grown from seed sown in the open ground. When sown in April the plants will bloom abundantly and continuously through the entire season. Of late, great improvements have been wrought both in the color and form of the flower. During the month of August zinnias are at their best. To secure large flowers and a profusion of bloom the plants must be given ample room for full development, as well as an abundant supply of food. Strong, rich soils suit the zinnia. If the seeds are sown in a dwelling house or in a hotbed in March and the young plants are pricked out once or twice before being placed in their permanent situations more satisfactory results will be secured than from outdoor sown seeds unless equal care in thinning or transplanting is given. The plants can be used for groups, beds, borders, garden lines, and summer hedges. Their average height is one and one-half feet.

L. C. Corbett,
Washington, D. C.

Planting Table—Flowers

Allow 10 days for every 100 miles north or south of New York. Indoor planting may apply to seeds started in the house, a hotbed or a cold frame, the last-named being available after the first of March in many sections. Weather may affect dates.

NAME	WHEN TO PLANT		DISTANCE APART (INCHES)	FLOWERING PERIODS	COLOR	COMMENT
	INDOORS	OUTDOORS				
Achillea	....	June-Oct.	12	July-Oct.	White	A perennial, two feet high.
Ageratum	March	May	6	June-Oct.	Blue, white	Annual, grown from seeds or cuttings.
Alyssum	....	May-June	4	June-Oct.	White	Excellent annual for borders.
Aquilegia	....	Sept.	8	June-Sept.	White, yellow, blue, pink	Hardy perennial. Blooms the second year.
Asters	April	May-June	9	July-Oct.	White, pink, yellow, red	Bedding annual. Use wood ashes.
Balsam	....	May	9	July-Sept.	Red, white, pink, yellow	Annual, to grow in clumps in the sun.
Calendula	....	May-June	6	June-Oct.	Yellow, orange	Easily grown annuals, that self-sow.
Calliopsis	....	May	6	July-Oct.	Yellow, brown	Annuals grow, but they like the sunny location.
Campanula	....	August	12	June-Aug.	Blue, pink, white	Perennial, blooming the second year.
Celosia	April	May	6	June-Oct.	White, red, pink, yellow	Annual
Candytuft	....	May 15-June 15	4	June-Oct.	Pink, white, red, purple	Annuals, for beds or borders
Centaurea	....	April	6	June-Oct.	Blue, white, pink	Annual, to grow in masses. Self-sown.
Chrysanthemum	April	May	6	July-Oct.	White, yellow, red	Annuals, for massing at a distance
Cobea	April	....	8	July-Oct.	Purple	Climbing vine. Plant seeds edgewise.
Cosmos	April	May	12	July-Sept.	White, red, pink	Tender annuals
Dahlia	April	....	36	Aug.-Oct.	White, yellow, pink, red	Late started plants give largest flowers.
Delphinium	....	June-Aug	12	July-Oct.	Blue, yellow, white	Tall perennials. Bloom the second year.
Dianthus	May	May	6	July-Oct.	White, red striped	Perennial, blooming the first year.
Digitalis	....	July-Aug.	9	July-Aug.	Pink, white, blue	Fine in hardy border. Bloom the second year.
Eschscholtzia	....	May	4	July-Aug.	Yellow, orange	Do not transplant. Foliage is pretty.
Gaillardia	April	May	6	July-Sept.	Yellow, red	Showy annual, for beds.
Gourds	April	May	4	Sept.-Oct.	Fruit-bearing	Excellent to hide unsightly objects.
Four O'Clocks	April	May	8	July-Sept.	White, pink	Annuals, for borders or beds.
Gypsophilia	April	May	10	July-Sept.	White	Fine to use for bouquets. Grow elegant.
Helianthus	....	May	12	July-Oct.	Yellow	Make a good screen. Try the new kinds.
Hollyhock	....	June	15	Aug.-Sept.	White, red, yellow, pink	Perennial. Spray with Bordeaux.
Kochia	....	April	12			
Larkspur	April	May	6	June-Sept.	Red, white, blue, pink	Grow in masses. Good for cutting.
Lobelia	April	May	4	June-Sept.	Blue, white	For low edgings.
Marigold	April	May	6	July-Oct.	Brown, red, yellow	Showy, easily grown annuals.
Mignonette	April	May	6	July-Oct.	....	Fragrant. Make successive sowings.
Myosotis	April	June	6	June-Aug.	Blue, pink, white	Perennial
Nasturtium	April	May	6	June-Oct.	Various colors	One of the best annuals.
Nicotiana	April	May	9	July-Oct.	White, pink	Annuals, opening toward evening.
Pansy	Aug.-May	April	4	April-Oct.	Many colors	Give a rich, cool, moist soil.
Petunia	Feb.-April	May	6	June-Oct.	Red, pink white	Tree-flowering annuals.
Phlox	April	May	8	July-Oct.	Red, white, yellow, pink	One of the best low annuals.
Poppy	....	April	4	June-Sept.	Red, white, pink, yellow	Do not transplant.
Portulaca	....	May, July	4	July-Oct.	Red, pink, yellow, white	For dry, sandy and sunny spots.
Pyrethrum	....	June	12	July-Aug.	Red, white, pink	Grow in masses. Good to cut.
Ricinus	April	May	36	No bloom	No flowers	Annuals, start in pots.
Salpiglossis	April	May	6	July-Oct.	White, brown, red	Good mid-summer annual and easy to grow.
Salvia	March	May	18	Aug.-Oct.	Scarlet	Give a green background and rich, sandy soil.
Scabiosa	April	May	9	July-Sept.	White, yellow, pink	Long-flowering annual.
Stocks	April	May	12	July-Oct.	Pink, white, scarlet, yellow	Good for beds and to cut.
Sweet Pea	....	April	3	July-Sept.	Many colors	Plant early in rich, moist soil, in the open.
Verbena	Feb.-April	May	6	June-Oct.	White, red, blue, pink.	Splendid annual for bedding in the sun.
Zinnia	April	May	6	June-Oct.	Red, yellow, white, pink	Good summer plant for beds.

DISEASES OF ORNAMENTAL PLANTS

Ornamental plants are for the most part subject to the same kinds of troubles as plants of the same species or family but which may have acquired more economic importance. Usually a reference to the list of diseases of kindred plants found in the main body of this work will give the reader the information needed for recognizing and controlling the diseases of ornamentals. A few of the more important ones are given in this section in alphabetical order with the exception of roses which may be found under *Rose* in the Floriculture section.

Anthracnose

Maples, oaks, lindens, sycamores and other trees are affected by some one of the anthracnoses. The leaves of young trees and shoots are affected. It may be controlled by the use of Bordeaux in the nursery and early in the season.

Reference

Duggar, Fungus Diseases of Plants.

Black Spot of Maple

Rhytsima acerinum (Pers.) Fr.

This fungus occurs on maples, willows and other forest trees. It appears as an irregular black spot upon the leaf. Not serious.

Carnation Bud Rot

Sporatrichum poae Pk.

A serious bud disease which has caused severe losses in greenhouses in several states. It causes a disfigurement of the flowers with eventual rotting of the entire flower in severe cases. Controlled by general sanitation and destruction of all diseased specimens by burning.

Reference

Duggar, Fungus Diseases of Plants.

Crown Gall

Bacterium tumefaciens

This disease is common to many species of plants. A full discussion will be found under *Apple Diseases.*

Decay or Brown Rot of Trees

Polyporus sulphureus (Bull.) Fr.

This fungus seems to be universal where trees are grown and attacks the elm, maple, oak, beech, birch, willow, poplar and many, if not most, other shade trees including the conifers.

When the fungus reaches the fruiting stage it appears as a bright, sulphur-yellow, sponge-like cluster, very striking in appearance. The spores find lodgment in wounds, broken limbs and knots and the growing fungus thus finds entrance to the heart wood, which decays and is eventually reduced to a brittle mass which may be readily ground to powder.

Control

The only practicable method of control is by painting wounds made by pruning or otherwise with some heavy antiseptic paint.

Reference

Duggar, Fungus Diseases of Plants.

Fusarium

A species of fusarium produces a wilt of China asters and a rosette of carnations. Sterilization of the soil seems the only remedy.

Reference

Duggar, Fungus Diseases of Plants.

Leaf Blotch

See black spot of maple, this section.

Rhododendron Rust

Chrysomyxa rhododendri (Dec.) DeBary

This is the most common disease of rhododendron and occurs in practically all regions where the rhododendron is native and particularly where spruce and fir abound as the fir is also a host plant. No method of control has been worked out.

Powdery Mildew

See under *Apple, Pear, Peach Diseases.*

Root Rot

Several forms of root rot attack carnations, violets, asters, etc. The trouble is most likely to occur in alkaline soils or soils poorly drained. Care should be taken not to set out plants which are already affected and attention to drainage and manuring to correct alkaline conditions will be effective. These rots have a wide range of host plants. See under potato, lettuce, beans, etc., where it appears as a damping-off and rhizoctonia. See index.

Root Rot of Trees

Various forms of root rot attack shade as well as fruit and forest trees.

These will be found fully discussed under diseases of the various fruit trees. See index.

Soft Rot of Calla

Bacillus aroideae, Town

This organism has caused a serious soft rot of the calla which destroys the plants about the time of blossoming.

The disease occurs chiefly in the bulbs, flower stalks and petioles.

Controlled by selection of healthy bulbs and by changing beds every three or four years.

Reference

Duggar, Fungus Diseases of Plants.

White Rot

Polyporus squamosus (Huds) Fr.

This fungus fruits in a conspicuous bracket. It is found upon many species of forest and ornamental trees.

Prevent by painting all wounds to prevent entrance of spores.

INSECT PESTS OF ORNAMENTAL PLANTS

These plants are attacked by much the same list of pests as infest similar species amongst the economic plants. Reference to the various fruits and vegetables belonging to the same family will usually furnish the reader with the desired information as to the method of control in the case of a pest of a given plant.

Holly

Holly is sometimes troubled with scale insects of various species.

They may be controlled by the usual methods adopted for the fruits, which see.

Ivy or Oleander Scale

Aspidiotus hederae (Vall.)

General Appearance

Circular flat scale, one-sixteenth to one-eighth of an inch in diameter, the male scales being very much smaller. The color varies from light to dark gray. On lemons this species often appears quite red and is occasionally taken for red scale (*Chrysomphalus aurantii*), but the lack of the small, central dark exuviæ together with its smooth, flat surface makes it easily distinguishable from red scale and also from the greedy scale (*Aspidiotus camelliae*), which is decidedly pointed.

Life History

Same as the other species of this genus of which the San Jose scale is given as typical. This species is cosmopolitan and is everywhere throughout the state. It is a greenhouse pest and often causes alarm to citrus growers by appearing on the fruit, but we find it attacks only old "tree ripes." It is perhaps most serious in many of the olive orchards in the Sacramento valley, where it infests the fruits so as to make them unfit for pickling purposes.

Distribution

Throughout the entire country.

Food Plants

Ivy, oleander, holly, boxwood, orange and other citrus species, olive, plum, cherry, currant, maple, camellia, grass, clover, yucca, asparagus, fern, pepper tree.

Control

Same as for San Jose scale.

Natural Enemy

A small chalcid parasite works effectively upon this scale.

E. O. Essig

Privet

San Jose scale. Sometimes troubles hedges of this plant. See under *Apple Pests.*

Red Violet Louse

Rhopalosiphum violae Perg

General Appearance

All forms are dark red; the wings are noticeably clouded along the veins which easily distinguishes this species from all others infesting violets.

Life History

Viviparous females, winged and apterous, bring forth young continually throughout the early spring and summer months. Evidently the entire life cycle is passed upon the violet.

Food Plants

Cultivated violets.

Natural Enemies

This species is usually held in perfect control by internal parasites.

E. O. Essig

Florida

Florida is mainly a peninsula 350 miles long by 60 to 100 miles wide. On the north there is an arm, reaching westward along the Gulf, more than 100 miles long and 50 wide, once known as West Florida. The extreme length of the state from north to south is 450 miles and it contains an area of 58,680 square miles, of which 4,440 is water. The surface is generally level, or slightly undulating; but in the northwest it is hilly, or at least broken and called hilly; yet none of the elevations rise more than 300 feet above the level of the sea.

For the main part the soil is formed of calcareous rocks, overlaid with sand, clay and drift. No state in the Union has so much coast line as Florida (1,150 miles) and none so many navigable rivers. Among the rivers navigable for steamers are the St. Mary, forming part of the boundary between Florida and Georgia, and navigable as far as the town of St. Mary's; and the St. Johns, which flows into the Atlantic near the northeast corner of the state. This river rises in the South, and with its tributaries and lagoons has more than 1,000 miles of navigable water. It flows through a series of lakes, lagoons and swamps, and for 150 miles above its mouth has a width of two miles. The Indian river is a narrow lagoon or sound about 100 miles long. The rivers rising in Alabama and flowing through Florida are the Perdido, Escambia and Choctawhatchie. Those rising in Georgia are the Appalachicola, Ocklockonee and Suwanee. Those flowing from Lake Okeechobee are Withlacoochee, Peace Creek, Caloosahatchiee. Rivers of the interior are Ocklawatha and Kissimmee.

The chief harbors of Florida on the Atlantic coast are St. Augustine, Fernando, Port Orange and Jacksonville, and on the Gulf coast Key West, Charlotte Harbor, Tampa, Cedar Keys, St. Marks, Appalachicola and Pensacola. Numerous lakes of pure water dot the state, the largest of which is Okeechobee, having an area of 500 square miles and discharging its waters by several outlets into the Everglades. The Everglades are swamps full of islands covered with vines and shrubbery, and in the rainy season mostly covered with water, forming an addition to the Lake Okeechobee. There are many small islands along the Gulf coast, and from the southern end of the peninsula, a chain of reefs and islands called quays or keys extend in a southwesterly direction for 200 miles. Many of the streams of Florida are subterranean, having been formed by the action of the water in wearing the limestone rock, which forms so large a part of the sub-stratum of Florida soils.

For agricultural purposes Florida may be divided into the Upland region, comprising the northern tier of counties; the Northern and Central Florida region, and the Treeless and Alluvial region, south of a line drawn from Charlotte Harbor to Cape Carnival. Again, the state is sometimes divided into sections designated by the natural productions or flora, as follows:

1. The oak, hickory and pine, upland region, comprising most of the northern tier of counties.
2. The long-leafed pine region, which lies chiefly in Northern and Central Florida, dividing it into rolling, flat and hummock lands.
3. The pitch pine, a treeless and alluvial region in the southern part of the state.

The hummock lands are small elevations or hillocks, rising above the surrounding swamps and generally covered with grass, shrubs or trees. Its surface soil is generally underlaid with clay and therefore the timber that grows upon it is adapted to the conditions described. All the fruit trees grown in Florida do well on the hummock lands, and it was formerly supposed they would not succeed on the sandy soils, but this has lately been proven a mistake, for by fertilizing from the marshes, or by the use of shells from the sea, or other methods, it has been proven that certain kinds of fruits, especially oranges, will reach a high state of perfection. There are many varieties of sandy soil, from the coarse sand containing 95 per cent of insoluble matter to the hummock lands mixed with clay. These differences have been caused by the action of the winds and waves and have made a scientific study of the qualities of soil and their adaptability to certain forms of vegetable life necessary in order to reach a fair degree of success. However, by a study of adaptation of crops to conditions men are making large profits in fruits and vegetables grown for the early markets of the Atlantic coast cities.

The principal fruits grown are the citrous fruits such as oranges, lemons, limes. Other species of fruits are peaches, pears, plums, grapes, Japanese persimmon, or kaki, strawberries, pineapples, bananas, guavas, mangoes and cocoanuts.

Many kinds of vegetables are grown among which are beans, beets, cabbage, cauliflower, collards, egg plant, Irish potatoes, lettuce, watermelon, muskmelon, onion, okra, English peas, pepper, radish, squashes, rutabagas and sweet potato.

The marl or drained lands of the southeast coast raise mostly tomatoes, egg plant, peppers and okra.

Cocoanuts are grown mostly along the coast and in the southern part of the state.

Bananas are not largely cultivated for the markets but are grown mostly for home use.

Grapes grow rapidly owing to the long season for growth and the vines of the native varieties grow to be very large. The Scuppernong is the leading variety and produces immense quantities of fruit.

Pears are rather subject to blight. The most resistant varieties are the Kieffer, Le Conte and Smith.

Peaches grow in almost all sections, but seem to prefer the hummock or flat woods lands, if these lands are properly drained. The varieties of peaches recommended are the Alexander, Early Cream, Florida Crawford, General Lee, Imperial, Angel, Colon, Ferdinand, Honey, Peento, Waldo and Yum Yum.

GRANVILLE LOWTHER

Varieties of Fruits and Nuts for Central and South Florida Planting

The following list is recommended by Griffing Bros. of Florida.

CITRUS FRUITS—Budded on Sour Orange and Rough Lemon Roots.

ORANGES—Early Ripening, Boone's Early, Parson Brown, Centennial, Medium Early, Homasassa, Medium Sweet, Tangerine, Mid-Season, Mandarin, Pineapple, Ruby, St. Michael's Blood, Tangerine, Washington Navel, Late Orange, Jaffa, King, Tardiff, Valencia Late.

GRAPE FRUIT—Duncan, Florida Common, Marsh Seedless, Pernambuco, Triumph.

LEMONS AND LIMES — Kennedy, Villa Francha Lemons, Persian Seedless, Florida Key Limes.

KUMQUATS—Nagami (oblong), Marumi (round).

NUT TREES—

PECANS—Bradley, Columbia, Curtis, President, Randall, Schley, Stuart, Van Deman.

Japanese Walnuts, Japanese Chestnuts.

PEACHES—Angel, Bidwell's Early, Bidwell's Late, Florida Crawford, Florida Gem, Glen, Gibbon's October, Griffings No. 4, Hall's Yellow, Honey, Howard, Jewell, Miami, Peento, Ceylon, Suber, Waldo.

PLUMS—Excelsior, Gonzales, Happiness, Kelsey, McCartney, Stumpe, Terrell.

FIGS—Brown Turkey, Brunswick, Celestial, Lemon.

JAPANESE PERSIMMONS—Hyakume, Okame, Triumph, Tana Nashi, Zengi.

PEARS—Cincincis, Keiffer, Magnolia, LeConte, Suwanee.

APPLES—Jenning's Florida.

MULBERRIES—Downing, Hicks, Merritt, Stubbs.

POMEGRANATE—Sweet, Purple Seeded.

GRAPES—(Bunch varieties) Agawam, Concord, Delaware, Elvera, Niagara.

GRAPES—(Muscadine varieties) James, Scuppernong, Thomas.

FROST AND PRECIPITATION FOR FLORIDA

Station	Frost				Precipitati'n
	Average Date of		Date of		
	First Killing in Autumn	Last in Spring	Earliest Killing in Autumn	Latest in Spring	Annual inches
De Funiac Springs	Nov. 21	Mar. 13	Oct. 27	Mar. 29	67.8
Pensacola	Dec. 5	Feb. 23	Nov. 12	Apr. 6	56.8
Talahassee	Dec. 8	Mar. 4	Nov. 4	Mar. 28	58.8
Jacksonville	Dec. 6	Feb. 19	Nov. 12	Apr. 6	53.4
Archer	Nov. 28	Mar. 9	Oct. 24	Apr. 16	54.9
Eustis	Dec. 28	Feb. 18	Nov. 28	Feb. 24	49.6
New Smyrna	Dec. 24	Feb. 17	Nov. 28	Mar. 18	51.1
Tampa	Jan. 9	Feb. 8	Nov. 28	Mar. 19	53.1
Bartow	Dec. 21	Feb. 16	Nov. 18	Mar. 17	54.5
Jupiter	Dec. 29	Feb. 14	Nov. 18	Apr. 7	58.7
Myers			Dec. 21	Feb. 14	55.1
Miami				Feb. 19	58.3
Key West					37.9

North Florida. For bloom period of Apples, see *Louisiana.*

Food

Time Required for Digesting

Food	How Cooked	H.M.
Apples, sour, hard	Raw	2:50
Apples, sweet, mellow	Raw	1:30
Bass, striped	Broiled	3:00
Beans, pod	Boiled	2:30
Beans and green corn	Boiled	3:45
Beef	Fried	4:00
Beefsteak	Broiled	3:00
Beef, fresh, lean, dry	Roasted	3:30
Beef, fresh, lean, rare	Roasted	3:00
Beets	Boiled	3:45
Bread, corn	Baked	3:15
Bread, wheat, fresh	Baked	1:30
Cabbage	Raw	2:30
Cabbage, with vinegar	Raw	2:00
Cabbage	Boiled	4:30
Carrot, orange	Boiled	3:18
Catfish	Fried	3:30
Cheese, old, strong	Raw	3:30
Chicken, full grown	Fricasseed	2:45
Codfish, cured dry	Boiled	2:00
Custard	Baked	2:45
Duck, tame	Roasted	4:00
Duck, wild	Roasted	4:30
Eggs, fresh	Raw	2:00
Eggs, fresh	Scrambled	1:30
Eggs, fresh	Roasted	2:15
Eggs, fresh	Soft boiled	3:00
Eggs, fresh	Hard boiled	3:30
Eggs, fresh	Fried	3:30
Fowls, domestic	Roasted	4:00
Hashed meat and vegetables	Warmed	2:30
Lamb, fresh	Broiled	2:30
Milk	Boiled	2:00
Milk	Raw	2:15
Mutton, fresh	Broiled	3:00
Oysters, fresh	Raw	2:55
Oysters, fresh	Roasted	3:15
Oysters, fresh	Stewed	3:30
Parsnips	Boiled	2:30
Pork, steak	Broiled	3:15
Pork, fat and lean	Roasted	5:15
Pork, recently salted	Stewed	3:00
Pork, recently salted	Fried	4:15
Potatoes, Irish	Baked	2:30
Potatoes, Irish	Boiled	3:30
Salmon, salted	Boiled	4:00
Sausages, fresh	Broiled	3:20
Soup, bean	Boiled	3:00
Soup, chicken	Boiled	3:00
Soup, mutton	Boiled	3:30
Soup, beef, vegetable	Boiled	4:00
Trout, salmon, fresh	Boiled	1:30
Turkey, domesticated	Roasted	2:30
Veal, fresh	Boiled	4:00
Veal, fresh	Fried	4:30

Forecasting Frost. See *Frost.*

Freight Rates of Movement in. See *Reduction of Waste in Marketing under Marketing.*

Frost

Frost is frozen dew; the moisture of the atmosphere crystallized by the cold. Young and tender plants are often injured by the frost, thereby causing much loss to the farmer and horticulturist. Inasmuch as the wealth of the world is mainly produced from the soil, all kinds of business and commerce are therefore affected by frost conditions and all classes, as well as the farmer and horticulturist, suffer loss. If, therefore, we could know the conditions and provide against them, it would greatly lessen the uncertainty of crops. With our present knowledge this can be done in a measure, but there is much to be learned and much to be accomplished before we can be fully assured against losses caused by cold.

Frost occurs only during calm, cold nights when the mercury is as low as 32 degrees Fahrenheit. This statement makes it necessary to distinguish between a frost and a freeze. There can be no frost without freezing, but there can be a freezing temperature without frost provided there is little moisture in the air. Freezing occurs at that degree of temperature at which water will solidify; or at which ice will melt. Thus the freezing point and the melting point, or the point of fusion, are one. The freezing point of water is 32 degrees above zero; the freezing point of mercury is 39 degrees below zero; the freezing point of sulphuric ether 46 degrees below zero, and the freezing point of alcohol, 203 degrees below zero. The freezing point of water is the approximate danger point of vegetable life. We call the degrees of the thermometer below the freezing point, degrees of cold; the degrees above the freezing point, degrees of heat. When the atmosphere which comes in contact with the body of a plant or animal is colder than the body, it absorbs heat from the body and is called cold, because it is so in relation to the temperature of the body. All animals and plants have a certain power of maintaining the heat of the body in defiance of external cold. This power in animals is due to the process of combustion, in which carbon and hydrogen taken into the system as food, unite with oxygen. This is accomplished by means of breathing, which oxygenizes the blood. The normal heat of the blood of birds is 100 to 112, while in mammals it is 96 to 102. Thirty degrees below this normal temperature is almost sure death, because at this point circulation stops; while ten degrees above is almost equally dangerous, for then the system is consumed by heat. Plants, during the summer, store food; they breathe and manufacture heat out of food particles just as do animals, but not in the same degree nor in the same manner. Plant life resists cold by the radiation of heat. There is considerable difference in the rapidity with which the different varieties of plants give off heat. This can be illustrated by the differences of radiation in soil, rock and water. Animals know that during the cool nights of spring and autumn, after the earth has become cool, by huddling up against a large rock they can keep warm. It has held its heat longer than the soil.

Horticulturists know also that adjacent to large bodies of water the temperature is modified by the radiation of heat from the water after the soil has lost a much greater degree of heat. An illustration of this is seen in Western Michigan along the eastern shore of the lake, where a strip of territory about 15 miles wide and 150 to 200 miles long is protected against cold by the milder temperature of the lake during the cold season, and that region is a good fruit-growing section, whereas other portions of the state grow comparatively little fruit.

Danger Point

There is considerable difference in the power of plants to radiate heat, and in the rapidity of radiation, and these facts determine in a large measure their resisting power to a temperature greater than that of their bodies. It is very interesting and yet very difficult to determine with exactness the degree of resisting power belonging to any particular plant, for there are so many counter influences that modify any rules. The Missouri Agricultural Experiment Station has found that dormant peach buds can stand a temperature of eight or nine degrees below zero with no injury. When the buds are appreciably swollen, zero weather is the danger point; when the buds are showing pink, they can stand 15 degrees above zero; when the buds are almost open, 25 degrees is the danger point; when they are newly opened, about 26 degrees would be the point of danger; when the petals are beginning to fall, 28 degrees above zero is cold enough to cause uneasiness; when the petals are off, they can stand 30 degrees above zero; when the "shucks" (calyx tubes) are beginning to fall off, 32 degrees above zero is the danger point. This shows the different degrees of resisting power of the same varieties of fruit during different degrees of development. The United States Department of Agriculture makes the statement that the danger point for apples when they are showing pink is 20 degrees above zero; in full bloom, 26 degrees above zero. Pears showing pink are in danger at 20 degrees above zero, in full bloom 27 degrees above; peaches showing pink, 23 degrees above and in full bloom, 28 degrees above. It will thus be observed that there is substantial agreement between the conclusions reached by the Missouri Agricultural Experiment Station and those of the United States Department of Agriculture, although these conclusions are differently expressed.

Mr. P. J. O'Gara states that in Southern Oregon the temperature at which the apricot is injured when in the bud is 28 degrees above zero, and 30 degrees when in blossom. Cherries are injured at 29 degrees, just before the blossoms open, and plums are injured at 30 degrees above zero when the flowers begin to show white.

It should be observed further that the latitude to which a tree is acclimated has much to do in determining the degree of cold it will stand without injury. Trees of the same varieties brought from Florida will not stand the cold of the Northern climate as well as those grown in the North, which have for several years, perhaps for generations, been used to the colder atmosphere. Furthermore, it makes a difference whether the cold comes suddenly or gradually. It is with plant life as with animal life, that the tendency of nature is to provide against injuries caused by sudden changes. Animals suffer more from cold if the change is sudden than if it is gradual. In the gradual changes there is a closing of the pores of the skin, a shrinking of the muscles and drawing upon the food substances for the manufacture of heat, a lighting of the fires of the system that protects in a degree not possible where the change is sudden. The same law prevails among plants, but not in the same degree. However, it is observable that following a very warm day, if it should turn suddenly cold, the fruit buds are much more subject to injury than if the same degree of temperature followed a cool day. In the winter of 1908 and 1909 in the Northwestern part of the United States, the temperature was lower during the months of January and February than for eighteen years before, and more damage was done to the tender varieties of fruit during that winter than had ever been known in the history of fruit growing in that region. We made in our own orchard and in the orchards of our neighbors the following observations:

First: Peach trees and the trees that belong to the prunus family, such as almonds and apricots, are among the tenderest trees and have less power to resist cold than apples, pears and other varieties. The almond will stand about 14 degrees below zero without killing; the peach will stand about 18 degrees. Among the varieties of peaches on our place the Early Crawfords were the tenderest, while the Elbertas, Carmens and Salways were comparatively hardy. A few feet of altitude when the mercury is down to the danger point may determine whether an orchard will be killed or not. For instance, in one orchard the trees were killed in a little depression or draw that ran through the place, but at a point twenty feet higher they were not killed. It was argued by some of the neighbors that this was due, in part, to the fact that this low portion of land was irrigated more and did not mature the wood as well, or that the wood was too sappy, and therefore more easily frozen. In making other observations I have concluded that there may be some force in this, and that if an orchard has been properly irrigated so that it has matured its wood normally, it is in better condition to stand the cold than where it is overirrigated, and therefore the wood sappy; or where it has lacked irrigation, and therefore the tree not sufficiently vitalized. Among the apples the cheaper varieties generally stood the freeze better than the higher grades. The exception to this rule was in the case of the Ben Davis, on which there was very little fruit the following year. It was shown that the English walnut is tender, and the wood was badly injured by the freeze. Pear trees were comparatively hardy, about a medium between peaches and apples, or perhaps a little nearer approach to the apple. Plums were not hardy; there was a fair crop of prunes and but few apricots, as the wood was not hardy. Pears were heavily loaded with bloom and bore a good crop.

The effects of rain or extra humidity should be remembered when considering the resisting power of a tree or plant. It is the same as with animal life. If exposed to rain, the body radiates heat much more rapidly than if it is kept perfectly dry. As has already been remarked, plants do not respond so sensitively to these changes of temperature as do animals, but any person knows that he has less power to withstand the cold if his clothes are wet than if they are dry. It is so with plants. If a cold wave follows a shower of rain, plants are much more sensitive to the cold and in much more danger of being killed than if the atmosphere is dry. The degree of vitality, also, in a plant, has much to do with determining its resisting power.

Conditions Which Affect the Frost Problem

There are three conditions that affect the frost problem. The first is elevation; the second is air drainage; the third is evaporation, usually from large bodies of water, which tend to modify the temperature.

In rough or hilly country there will be what is known as thermal belts, usually following the contour of the hills. Low or pockety lands will be relatively cold while higher situations above the level of the natural air outlets will be relatively warm and orchards situated on this higher land will not be so liable to suffer from frosts.

There are valleys that are often called lowlands through which the air currents sweep with force enough so that there is seldom frost to injure the vegetation. Reference has already been made to protection by lakes, bays, inlets or bodies of water that modify the temperature. Even several miles inland this is often true. For instance, the prevailing winds from the Pacific ocean are generally from the west or northwest. These winds are obstructed by the Cascade mountain range so that the territory along the foothills on the east side of the mountain range is more or less protected from the winds, but there are mountain passes like the Cowlitz pass, for instance, through which these winds sweep with considerable force. The air currents coming through the Cowlitz pass and sweeping down the Naches valley, which is part of the drainage system of the Yakima and Columbia rivers, modifies the temperature in the Naches valley so that, while the valley itself is not at a higher elevation, only being about 1,100 to 1,500 feet above sea level, yet they are seldom injured by frosts, while the lands in the Ahtanum valley, only a few miles separated from the Naches and on substantially the same level, but sheltered from the winds of the coast by a higher elevation of the mountain, generally are not quite so well protected from frosts and ordinarily there will be a little more danger to fruit crops in the Ahtanum valley on a general elevation than in the Naches; but there have been notable exceptions. One of these exceptions was in April of 1911, when a cold current of air came down from the north and settled in the Naches valley, and did as much damage or perhaps more than in some of the other valleys on the same level. There are exceptions to the general rules growing out of the changes in the direction of the wind, but the fact still remains that wind currents have much to do in preventing the settling of frosts upon the earth's surface.

The question of how the higher altitude furnishes better protection from frost than the lower is one about which a great many persons inquire. We can perhaps better answer this by saying that we are living upon the bottom of an ocean of air very like the ocean of water in which living creatures breed and grow. This ocean of air is not less than fifty miles deep, and is perhaps much deeper than that. One law of this atmosphere is the same as the law of the sea, that is, that cold contracts it and increases its weight, while the heat expands it and lightens its weight, so that, because it is heavier the coldest air tends to settle into the lowest places on the uneven surface of the earth just as the coldest water tends to settle into the lowest places on the uneven bed of the ocean. This law may be demonstrated in the heating of our homes. Those whose homes are heated with hot water know that the pipes which carry the hot water from the furnace to the upper rooms are called the hot water pipes and that the hot water rises from the boiler in the furnace room to the upper rooms of the building, and that after the same water has been cooled by contact with the air of the upper rooms, it is carried back by return pipes into the furnace room to be reheated and rise again. Thus is kept up the general round of circulation during the winter. Another illustration is in the circulation of the air in our homes from hot air furnaces. The heated air rises from the furnace, pouring from the registers and driving the cold air of the rooms into the lower story where by means of cold air ducts it is carried into the furnace room either to be reheated or to be carried away from the house. Every traveler has noted how, after the sun has set and the air is cooling, the colder air tends to settle in the valleys, while the warmer air tends to rise to the higher altitudes; he knows that in ascending the hillsides he will sometimes feel very sensibly a change in temperature in a distance of a few feet. During the day, especially in the summer time, the temperature of the valleys is warmer than that of the higher levels, because the radiation and reflection are greater. This can be illustrated. If we stand beside a large building on a hot day and get the direct rays of the sun at the same time that we get the reflected rays from the building, we will find that it will be much warmer near the side of the building that reflects the sun's heat than it will some distance away from the building. During the day the south slope of a hillside receives the direct rays of the sun's heat, during the night these hills radiate that heat and send it into the atmosphere to warm the colder air coming down from the hills. An illustration of this heat radiation at night is seen in the heated stone buildings and pavements of a great city where long after midnight the walls and walks are hot, especially during the hottest weeks of summer. We have seen persons trying to sleep on the beaches or in the parks at night because the radiated heat from the buildings in which their rooms were located was unendurable. These facts, together with the uneven surface of the earth, cause a constant circulation of the atmosphere of our globe.

Why the Highest Mountains Are Covered With Snow

If heated air rises and cold air settles it is pertinent to ask why the highest mountains are covered with snow and why the air is colder as we ascend. There are two principal answers to this question.

The first is that or near the surface of the earth there are innumerable particles of dust and layers of clouds and vapor that act as a blanket or covering to hold the reflected and radiated heat from the earth's surface. It is the same principle as when we sleep in a cold room, the covering on the bed which keeps us warm does not warm the atmosphere of the room, but it holds the heat radiated from our bodies. So, if we rise above a certain altitude, we rise above that blanket of dense atmosphere which we call the earth's covering.

Another reason is that in the highest altitudes of the mountains there is less friction of air currents, less generation of heat through friction, and therefore after ascending above the vapor, dust and clouds into a rarer atmosphere it becomes colder. We say "we rise above the clouds," but we speak in comparative terms, because we have not, in ascending the highest mountains, gone beyond all clouds, but beyond the general altitude of clouds. An illustration of this is seen on the Pacific coast where the prevailing winds are from the west. These winds carry the clouds against the mountain range and deposit a large amount of rainfall on the western slope. Comparatively a small amount of moisture is carried in currents high enough to cross the mountain range from the west to the east, for the average amount of rainfall on the west side is about forty inches per annum, while the average amount on the east side would be about ten inches per annum, or only one-fourth that of the west, but of the amount that is carried across the mountain range from west to east the highest peaks and the eastern slopes receive their share in the form of snow and ice, and the air is never warm enough at that altitude to melt it. When we say, therefore, that the higher altitudes are warmer, that is true up to a certain point; it is true in summer where there is much radiation of the sun's heat from the surface of the earth and after the sun has set and the cool air of the mountains is coming down the valleys; it is also true up to a certain altitude only, but beyond that the higher we ascend the cooler the atmosphere.

GRANVILLE LOWTHER

For additional information on orchard sites and soils, see *Selection of Site* under *Apple Orchard.*

FROST AND FROST FORECASTING IN THE NORTH PACIFIC STATES

[*] Protection against frost injury is by no means a new thing, although perusal of some recent writings and discussions would lead one to believe that it is. As a matter of fact, however, the protection of plants and fruits from frost injury dates back perhaps more than two thousand years. It is known that the Romans practiced heating and smudging as a protection against frost injury; this fact is vouched for by Pliny, who recommended the practice. Smudging was also recommended by Olivier de Serres, a French agriculturist, in the sixteenth century. He recommended the use of wet straw and half-rotten manures so as to produce a heavy smoke. In the latter part of the eighteenth century the practice of smudging was compulsory in parts of Germany, and failure to comply with certain set regulations resulted in prosecution before an officer of the law who imposed exemplary punishment. It is also recorded by Boussingault that the Indians of Peru practiced frost prevention, and that this was inherited from the pre-Spanish civilization. A reference to the literature which we have at hand shows some of the earlier work in frost prevention was by no means so crude as one would suppose. As a matter of fact, some of the modern practices are less scientific in their adaptations than the earliest attempts at frost prevention of which we have any record. During the eighties and early nineties the French vine growers did some remarkable work; and we find them even at that time using heavy oils as fuel, placing these oils in flat ironware dishes. There were also used many prepared fuels, which would render a very dense smoke. There had also been devised systems of automatic lighting which were more or less successful. These systems were operated by a mercuric column, not very much unlike some of our modern automatic alarm thermometers. Even at this time it was understood that there is a certain advantage in co-operation in frost prevention since the work done by one grower nearby aided in the protection of the crops of others. About the same time that the French vine growers were carrying on their work in frost prevention by certain heating and smudging devices, our California and Florida orange growers were experimenting. At this time some of the deciduous fruit growers of the Sacramento valley and elsewhere in California were also working along this line.

Mr. Edward A. Beals, of the U. S. Weather Bureau, located at Portland, Oregon, says with respect to the history of frost prevention in the Northwest:

[*] Very few growers in the Northwest a few years ago made any attempt to protect their orchards from frost, and those that did were not very successful,

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[*] Office of Pathologist, Medford, Ore. Bulletin No. 5.

[*] Weather Bureau Bulletin No. 41.

as their methods were crude, and where the necessity was greatest the orchards were badly located and the task was almost hopeless from the start. Frost warnings were issued by the Weather Bureau during that time, although very little attention was paid to them, as foreknowledge of frost is of practically no benefit to the horticulturist unless he is prepared to protect his crop from threatened injury.

In 1907 Mr. P. J. O'Gara, one of the scientific assistants in the Bureau of Plant Industry, was sent to the Rogue River valley to study the pear blight, which was making inroads among the pear and Spitzenburg apple trees in that section of the country. He quickly realized that the fruit growers were losing much more fruit by spring frosts than they were willing to acknowledge, and being familiar with orchard-heating methods in California, he soon induced a number of orchardists to adopt similar methods in the Rogue River valley. The plan was so successful the first year that it was tried the next on a fairly large scale and with even greater success. In the meanwhile a few orchardists in other important sections had taken up this work, and by the spring of 1910 the movement had obtained large proportions in four important fruit centers, viz.: Rogue River valley, Yakima valley, Lewiston orchard district, and the Boise orchard district.

ROGUE RIVER VALLEY

* When Frost May Be Expected and Where Frost Is Likely to Occur

The conditions obtaining in the Medford district are thus described by Mr. P. J. O'Gara:

In the spring it is found that during the day, that is between sunrise and sunset, the wind blows mostly from northerly quarters. These winds are not moisture laden as a rule, the relative humidity often being as low as twenty-five per cent at a temperature of seventy degrees Fahrenheit. During the night when frosts are likely to occur the winds die down altogether, or change to a southerly quarter. The winds from the south are very dry, and the relative humidity is often much lower during the period in which the winds come from the south. If the winds continue to blow from the northwest or westerly quarters, frosts rarely occur, because these winds tend to raise the dewpoint, or, in other words, bring in air with a larger percentage of water vapor present. While the water vapor content of the atmosphere is high, damaging frosts cannot occur. It is only when the dewpoint temperature approaches the freezing point or is below it that we may expect a serious freeze. As a rule it is only on the valley floor that serious injury may be caused by low temperatures during the blooming period or some time thereafter. Even on the valley floor where there may be some slight elevation no frosts occur, while serious injury may result only a few feet below. The hillsides surrounding the valley usually escape frosts altogether, and the average variation in temperature in favor of the lands lying above the valley floor is from five to six degrees; therefore, even though a heavy frost may occur on the valley floor, the temperature may not go to freezing on the uplands. During the past season some records were made by observing temperatures on and near the ground, as well as on the roof of the Garnett-Corey building, which is fifty feet above the street level. While temperatures ranged as low as twenty-three to twenty-five degrees on the ground and four feet above it, the temperature on the roof was from thirty-two to thirty-five degrees. There is at times, therefore, a difference of twelve degrees or more between the temperature on the ground and at a height of fifty feet above when taken on the valley floor. Under usual conditions we are quite safe in saying that there may be little danger to the crops on the higher lands surrounding the main floor of the valley.

The experience of the season of 1911 indicates that a heavy rain followed by a cold wave gives practically the same temperature on valley floor and hillsides, and also that under certain conditions

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* Office of Pathologist, Bulletin No. 5.

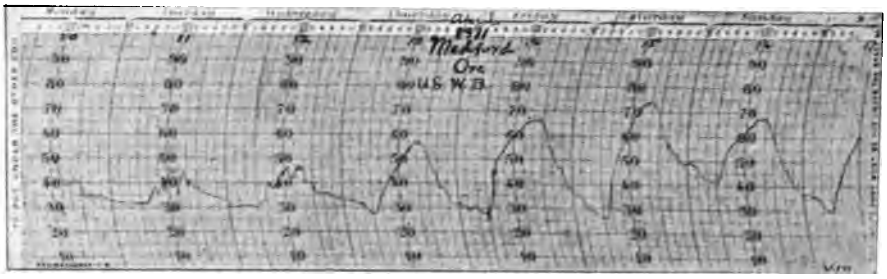

Fig. 1. Official Thermograph Record, United States Weather Bureau, Medford, Oregon. April 10 to 17 inclusive.
Note the short space of time during which low temperatures prevailed.

the injurious temperature may not continue for more than two hours and in some cases but a few minutes.

Frost Prevention

* High winds never occur during the time that the temperature may be below the freezing point. A slight breeze usually comes up from the south during the early morning. However, this breeze is never sufficient to more than waft the smudge through the orchards and does not interfere to any great extent in keeping up the temperature where fires are built. It will be seen that the conditions in the valley are ideal for the prevention of injury from freezing.

† The Rogue River valley is surrounded on all sides by mountains ranging from 4,000 to 5,000 feet above sea level, and with many peaks much higher. During periods of frost it is usually calm, and in the several years during which careful observations have been made the greatest movement of the air recorded during a spring frost has been from one to three miles per hour. Contrast this with the severe freezes which have occurred in other districts where wind velocities ranging from twenty to thirty-eight miles per hour were recorded when the thermometer stood at fifteen degrees or more below the freezing point. The fruit growers of the Rogue River valley little realize the wonderful climatic assets they are so fortunate to have. It can be truly stated that the only reason for losing a crop by frost is carelessness or neglect.

YAKIMA VALLEY

The conditions in the Yakima valley are described by Mr. T. R. Reed, special observer for that district.

The conditions favorable for frost in the Yakima valley include the usual conditions of high barometer following a spell of cloudy, cold weather in which the soil has lost its accumulated heat, clear sky and very light or no wind. It is considered by local observers that frost is most likely to follow a period of bad weather and the shift of wind from the south or southwest into the northwest or north. It is popularly supposed that danger of frost is small unless the veering to northerly quarters has been preceded by quite a marked period of southerly wind. This of course may be a popular way of indicating the necessary intensity and duration of the cyclonic low* occupying the Northwest; but it is worthy of note that judging from observations this season, dangerous frost is not likely except following protracted cloudy and cold weather, and that all the really serious frosts of the season have followed days on which the maximum temperature has been under 65 degrees and the current temperature under 60 degrees at the time of the afternoon observations.

High barometer alone, while causing frost in other localities in the state, has repeatedly failed to bring freezing temperatures to this valley, attributable partly, perhaps, to active air movement often occurring in connection with anticyclonic weather. A freeze may occur

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* Farmers' Bulletin No. 401.

† Office of Pathologist, Bulletin No. 5.

* Note—An area of low pressure at the northwest of a given point would be accompanied by southwest or south winds.

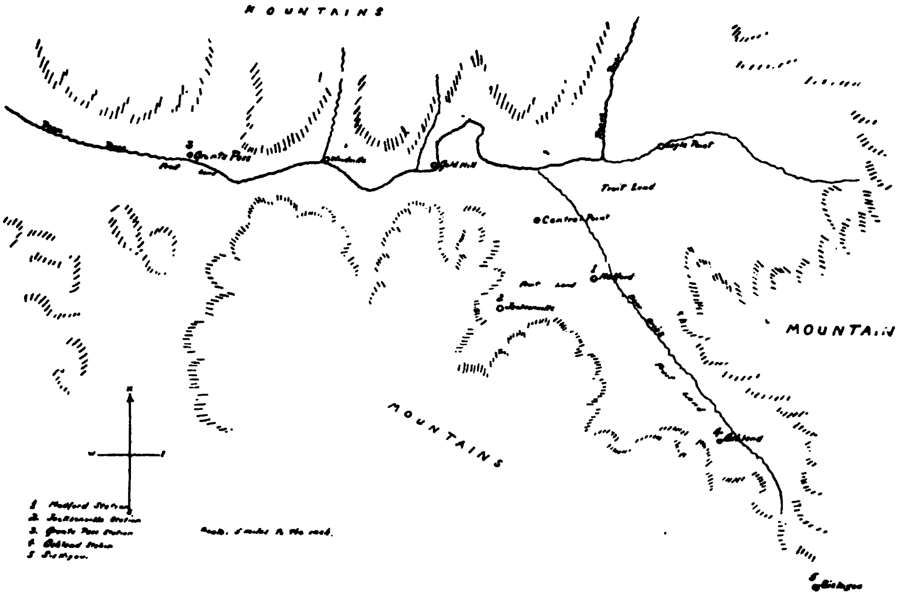

Fig. 2. Rogue River Valley Fruit District.

—*After Reed.*

here when the Northwest is occupied by low pressure; in fact, when a rain forecast would seem more legitimate than a frost warning, as on the night of the 6th of April; but this is an uncommon condition. Under such conditions the barometer may show no fluctuation worth speaking of, the surface currents may be from the south, in fact nothing to warrant a frost warning being issued except the fact of a clearing sky and a sharp fall in temperature.

The forecaster has then to determine whether the wind is to remain light and the sky clear, and this is an extremely precarious undertaking. Perhaps the daily rise in the barometer occurring at the time his decision is being made adds to the difficulty; and he must be able to distinguish to a certain extent between the periodic and the unperiodic movement, for it is the latter upon which he depends in a large measure to foretell the condition of the sky. Under such conditions, and unless the forecaster is sure of his position, it is wiser to place on their guard those who wish to protect their orchards, for the growers would rather be warned a few times unnecessarily than to have freezing temperatures descend on their orchards without forewarning.

The freeze occurring on the morning of April 6, 1911, when the temperature at North Yakima dropped to 25 degrees, could scarcely be foreseen, either from the weather map or from local observations, but it is a type of local freeze which should be studied and for which the local observer should be constantly on guard.

The ensuing freezes, which occurred with unusual frequency and severity for this section, were more easily foreseen. Between the inclusive dates of April 5 and 15 nine heavy frosts were recorded in North Yakima, and during the first half of the month there were more than this number in the neighborhood of Moxee and on the low ground below Union Gap. Seven times the minimum temperature dropped to 28 degrees or lower at the North Yakima station. The severest freeze of the entire period occurred on the morning of the 13th of April. The North Yakima station registered 24 degrees; in Moxee 16 degrees was reached, and the temperature in the lower valley ranged from 17 degrees at Sunnyside to 28 degrees at Parker Heights.

On the two mornings following what was very nearly a repetition of the phenomenal temperatures of the 13th was experienced. It was undoubtedly a strenuous period for the fruit men and one which is not likely to be repeated for many years. It showed the necessity of using an ample number of smudge pots and also the value of orchard firing on a large scale, showing the greater ease of heating a large district than a small one, or one in which heating is practiced only in a sporadic way.

North Yakima men were unsuccessful in maintaining safe temperatures, partly because they used too few pots—generally about 40 to 50 to the acre—and partly because each heated orchard was surrounded by unheated ones, and the wind, which was a feature of several frosty nights, effected a dispersion of heat and smoke. When practically all the orchardists fire, windy conditions can much better be coped with. On the morning of the 11th in particular orchardists reported that whereas under ordinary circumstances they could raise the temperature six degrees to seven degrees with 55 pots to the acre, on this morning it could only be raised three degrees. On the south slope of Nob Hill the smoke blew rapidly away, scarcely reaching the lower branches of the trees.

It was on this night (10th-11th) that the severest freeze occurred in the Nob Hill and Fruitvale districts, which are generally least affected by frost, the former being considered immune. The thermometer in the Weather Bureau shelter in North Yakima registered 29 degrees, and in Moxee 28 degrees; 31 degrees was reported from Parker, 28 degrees from Zillah, and 33 degrees from Sunnyside. That conditions as usually experienced suffered a complete reversal will be seen when it is stated that the temperature

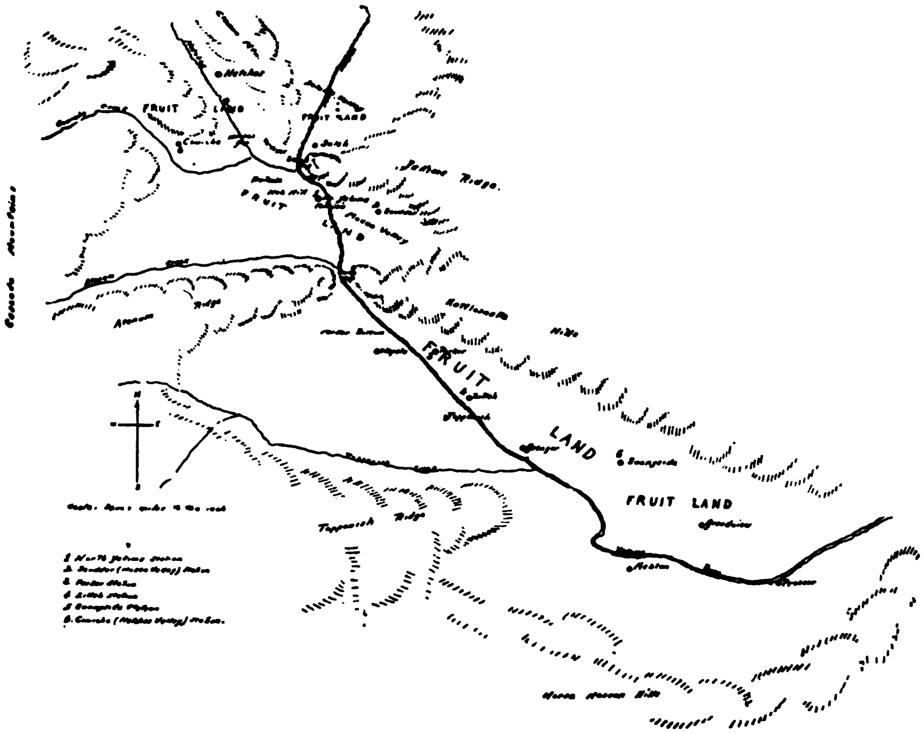

Fig. 3. Yakima Valley Fruit District.

—*After Reed.*

on Nob Hill and Fruitvale varied between 20 degrees and 23 degrees.[*] The reports from these districts showed much uniformity and many readings were made from reliable instruments. Moxee varied only a degree from North Yakima, and Sunnyside, which more often corresponds with Moxee, was even warmer. An interesting problem is here presented and its solution may disclose some interesting facts. The following is suggested by observations this spring:

A study of a topographic map of the region should be made in order to appreciate the situation. The Yakima valley is inclosed on all sides by mountain ranges varying from 2,500 to 3,000 feet in height and higher in the Cascades to the west. Access is had to the valley by two gaps on the north and one on the south. Nocturnal air drainage will always be from north to south under normal conditions, following the slope of the land, and observations show this actually to be the case. Fruitvale and the northern slope of Nob Hill are the first to benefit by the northwest breeze from the Naches canyon, as they lie directly in its course and in close proximity to the Nachez gap, from which it issues. There may be a similar breeze from Selah gap, a little to the eastward, but observations do not cover this point, nor are there any extensive orchards in line with Selah gap to benefit by such a breeze if there were one.

The Naches valley above Naches gap forms a natural reservoir for the air drainage from a vast mountainous area, and it is natural to conclude that when the convergent air is expelled into the Yakima valley below through the outlet formed by Naches gap a mixing of the air and possibly an adiabatic warming ensues, which would account for the comparatively higher temperatures encountered in the region lying directly in its path, as at Fruitvale, and the comparatively lower temperatures in the Fairview and Moxee districts, which lie several miles southeast of Fruitvale.

The Weather Bureau station is located in the city of North Yakima, and, therefore, between the two districts under discussion, Fruitvale being northwest of the city and Fairview and Moxee southeast. The thermometer at this station strikes a pretty fair mean, for while Fairview is often two degrees and Moxee five degrees to eight degrees colder than the North Yakima station, Fruitvale is usually a few degrees warmer. As the breeze from Selah gap spreads out and flows across the valley it loses its force, its temperature is lowered by radiation, and with further southeastward movement its character is changed from a protective wind to a more or less destructive one.

On the morning of the 11th, when the conditions in these districts reversed, a freezing wind was blowing from the south and southwest, having blown from this quarter throughout the night. There was no counter breeze from Naches gap, and the minimum temperature reported from the Naches valley above, a district from which comparatively high temperatures are usually looked for, was 22 degrees. Thus it appears that strong connection exists between a reversal of the customary wind direction and a reversal of temperature conditions in the several localities under discussion.

Boise

EDWARD L. WELLS

(See diagram C)

The Boise valley is well suited to the growing of such fruits as apples, pears, prunes, sour cherries, and common berries. Some fruit has been grown in the valley for many years, but it is only within the last few years that scientific fruit growing on a commercial scale has become an important industry.

While the entire region is more or less subject to spring frosts these frosts are rarely sufficiently severe to cause widespread damage. For this reason, prior to

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[*] This statement was based on temperatures as recorded at Scudder's station, located at the mouth of the Moxee valley. Had we more stations in the valley southeast of Scudder's I believe they would show that minimum temperatures do not vary a great deal from those recorded at Bender's station in North Yakima. The district at the junction of the Moxee and Yakima valleys, represented by the Scudder station, is probably the coldest in the region above Union gap, due to the air drainage from not only the Selah and Naches valleys, but also from the Upper Moxee.

1909, comparatively little attention was given to measures to protect fruit from frost injury. The spring of 1909 was one noted for a succession of damaging frosts, resulting in almost a complete failure in many orchards. This failure turned the attention of the growers toward protective measures, and some of the more progressive of them provided themselves with oil pots and oil for use in 1910. The spring of 1910 was much more favorable for fruit than that of 1909, so much so that there was a good yield of fruit in most of the unprotected orchards, as well as in those that were protected. This being true, there was little increase in 1911 over the area heated in 1910; the entire area in the upper part of the valley adjacent to Boise probably not exceeding 1,000 acres. Like that of 1910, the spring of 1911 was not a good one to demonstrate the efficiency of protective measures, for while some very low temperatures were experienced, these low temperatures occurred when the buds were least susceptible to injury, and little damage occurred that could be directly traced to frosts.

It is probable that orchard heating will not become common in this valley as it is in the Grand valley in Colorado and in the Rogue River region in Oregon, until another season like that of 1909 is experienced, when the practical value of heating can be demonstrated.

The topography of this region is peculiar and gives rise to some weather conditions that make frost forecasting a difficult matter. The Boise river, in its upper reaches, flows through a rugged mountainous region. About six miles southeast of Boise it emerges from a deep box canyon, the mouth of which marks the head of what is known as the Boise valley, which extends thence northwestward with increasing width toward the Snake river. Northeast of Boise are the Boise mountains, reaching in 12 miles an elevation of 7,500 feet, or 4,800 feet above the city. Toward the southwest the ground rises in a series of widening benches. Through this bench land, where most of the large orchards are located, run several water courses, rather unimportant naturally, but forming a means for air and water drainage, and apparently playing an important

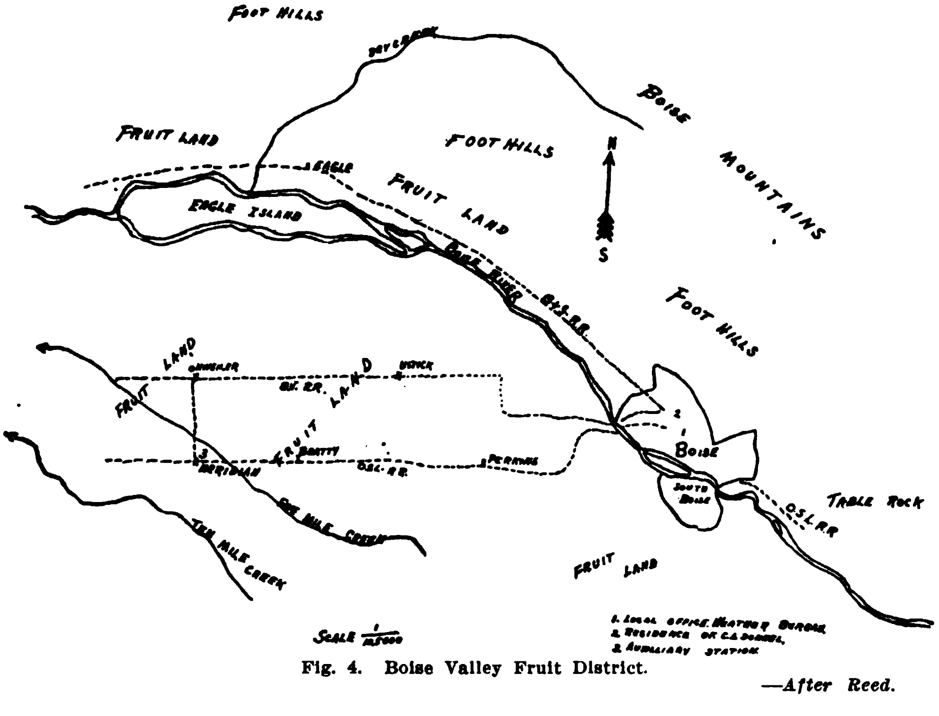

Fig. 4. Boise Valley Fruit District.

—*After Reed.*

part in determining local temperatures on frosty nights. The entire region may be classed as arid, having approximately 13 inches of precipitation annually at Boise, and somewhat less at points away from the mountains. Water for irrigation is supplied by the Boise river.

In fair weather there is quite a noticeable mountain and valley breeze blowing down the valley, or from the southeast from early morning to about 10 a. m. and up the valley or from the northwest in the afternoon. Frosts occur ordinarily upon the approach of a strong high-pressure area from the northwest. The outflow from this high, combined with the ascending currents already mentioned, makes a strong northwesterly wind in the afternoon, which has come to be considered as the surest indication of frost. At night, in addition to the ordinary nocturnal lessening of the wind velocity, the descending current opposes the outflow from the high, causing a stagnation of the air highly favorable for the occurrence of low temperatures near the ground. At such times there is a noticeable tendency for the colder air to settle into the shallow depressions along the water courses already mentioned. When conditions for rapid radiation are particularly favorable no two thermometers in the valley will indicate the same temperature. At other times the distribution of temperature is fairly uniform. Whenever there is any considerable amount of wind at night frost does not occur.

Sometimes when the crest of the high reaches or passes this region before morning an easterly wind will spring up. A brisk easterly wind, coming as it does off the mountain range, partakes of the nature of a chinook. Usually the effect of these chinooks is hardly noticeable except over Boise and the belt of land lying between the foothills and the river. Sometimes, however, the effect becomes noticeable on the bench lands, and on rare instances the chinook has been known to pass over the city and materially affect the temperature on the bench.

Lewiston-Clarkston District

For the purpose of a study of the temperature conditions at different points in the valley a temperature station was established in a favorable location in the Clarkston (Wash.) section, one and a half miles southwest of the Weather Bureau station.

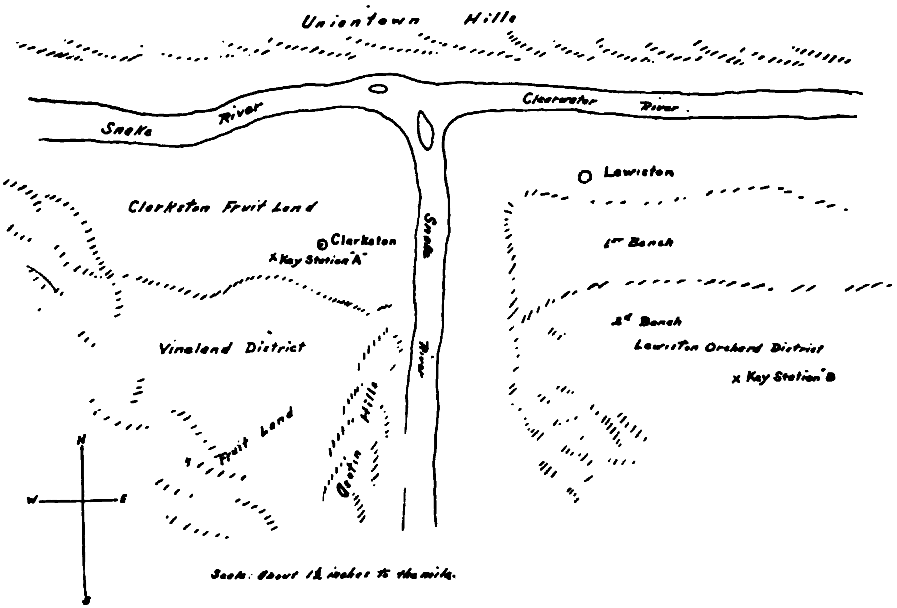

Fig. 5. Lewiston-Clarkston Fruit District.

—*After Reed.*

Owing, however, to the fact that orchardists have not taken up the idea of orchard heating to the extent that has characterized certain other sections, there has not been given the careful study to conditions here as elsewhere.

COLORADO

Grand Junction District

The most distinctive climatic feature of this section, especially of its lower valleys, is the comparative uniformity of the weather conditions from day to day. This is due to the high mountains, which practically surround the section and deflect the course of low pressure areas. A storm approaching from the west will usually cross the Continental Divide either to the north or the south of Colorado, where the height of the mountains is less. In consequence, the sudden changes that attend the passing of a low center are rarely experienced here. Severe cold waves, so common on the Eastern plains, are comparatively rare. There is, on the contrary, a tendency for a stationary area of high pressure to form over this region in winter, where it may remain for days, and even weeks, together. When one of these highs controls the weather, the sky is clear, the wind light, and of the mountain and valley type, the day temperatures are moderately high and remarkably uniform, and the nights cool, but seldom excessively cold, except when the ground is covered with snow, and where the air drainage is poor.

The annual mean temperatures range from 52.5 degrees, at Grand Junction, to less than 32 degrees, at the higher levels.

The night temperatures depend largely on the topography, air drainage exerting a greater control over this factor than does the absolute elevation. The mildest weather, in cold spells, is found where the night wind is the strongest, which is usually below the larger canyons. The comparative freedom from frost experienced by such regions has led to the development of an extensive fruit-growing industry.

The growing season, or interval when frost is not to be expected, varies greatly in different localities. Where longest (in the Grand valley), it extends from early in April to late in October; above 9,000 feet, frost may be expected every month. It is probable that the growing season is longer, in most localities, than is indicated by the attached frost table; a temperature of 32 degrees, which is taken as the standard, is not generally destructive to the staple crops.

Average Date of Killing Frosts

Stations	Length of record years	Last in Spring	First in Fall	Precipitation Av. Annual Inches
Cedar Edge	11	May 20	Sept. 23	11.02
Colbran	8	May 26	Sept. 24	15.16
Delta	13	May 16	Sept. 25	7.82
Durango	12	May 28	Sept. 26	17.51
Grand Junction	16	April 18	Oct. 18	8.74
Grand Valley	14	May 10	Sept. 29	12.30
Lay	9	June 16	Sept. 6	12.70
Mancos	10	June 9	Sept. 17	16.88
Meeker	14	June 12	Sept. 12	16.10
Montrose	10	May 16	Oct. 2	9.50
Pagoda	13	June 12	Sept. 3	18.26
Paonia	8	May 5	Oct. 3	12.16
Silt	12	May 21	Sept. 27	11.99
T. S. Ranch	8	April 27	Oct. 10	10.69

In the lower valleys the amount of sunshine is large, especially during the summer months; the greatest cloudiness is usually found in spring.

At the lower levels the wind movement is light, and is commonly of the mountain and valley type. The wind blows toward the mountains in the afternoon, and in localities attains considerable velocity. After sunset the wind subsides, and toward morning there is a light breeze from the mountains toward the lower levels. At the summits of the mountains the winds are generally from the west, and are frequently very strong in winter and spring.

The precipitation, up to the 10,000-foot level, is fairly represented by the table. It will be seen that, in the principal agricultural districts, the average is less than 15 inches, and is less than 10 inches over important areas. There is an increase in precipitation with altitude up to the highest points where observations have been made; an annual mean of more than 40 inches is indicated for certain localities.

By far the most important part of the precipitation occurs in winter and early spring, March and April being usually the months of heaviest snowfall. In the southern counties there is a pronounced tendency toward drought in late spring and early summer; June is often practically rainless. From the latter part of July until September, thunderstorms are common, but the precipitation is seldom heavy, except in the San Juan mountains.

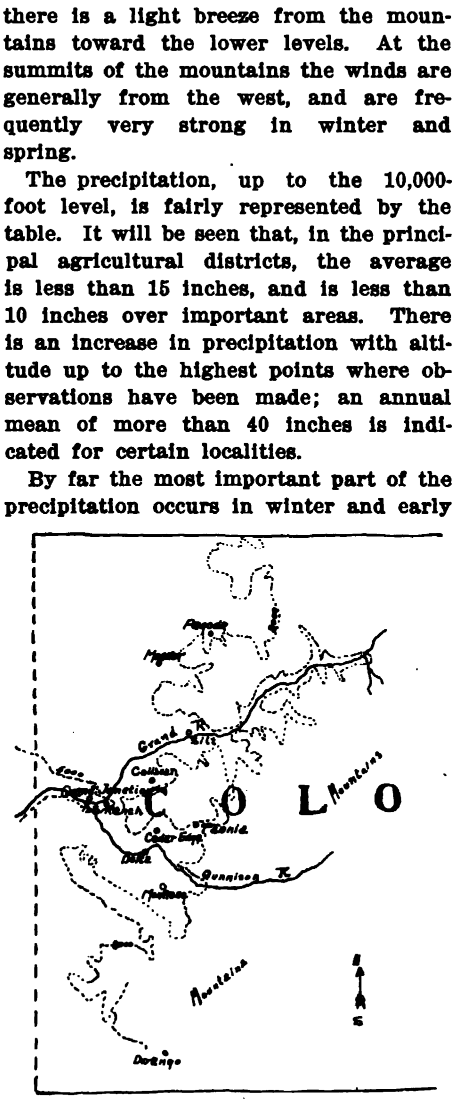

Fig. 6. Grand Junction Fruit District, Showing Position of District Below the 8,000-foot level. (U. S. Weather Bureau.)

The snowfall in the lower valleys is light, and remains on the ground but a short time. With increasing elevation, the depth increases rapidly; near the mountain summits a total fall of over 30 feet has been observed in a single year. At the very highest levels, practically all the precipitation is in the form of snow. Although the depth of snow varies much from year to year, the fall is so great that there are but few streams in this section that do not carry enough water for present needs, even in a dry season.

FREDERICK H. BRANDENBURG,
District Forecaster.

The Occurrence of Injurious Spring Temperatures in the Fruit Districts of Western Colorado

The fruit district under consideration embraces portions of the Grand and Gunnison valleys and branches thereof in Mesa, Delta, Montrose and Garfield counties in Western Colorado. The fruits principally raised are apples, peaches and pears. On account of variations in elevation, topography, air drainage, etc., fruit in some sections reaches a tender stage and is liable to injury (sometimes by the latter part of March), while that in other sections is still dormant. But, on the other hand, the later localities are the most likely to be visited by late spring freezes, and danger there is not entirely over until after the first of June.

The Grand valley fruit section is the lowest in elevation in the district and, in general, the earliest. Near the upper end it is narrow, and protected on the north by the Little Book cliffs, which rise more than a thousand feet abruptly almost from the edge of the orchards. In general the valley slopes towards the

Grand river, and down stream at the average rate of about ten feet per mile; so that air drainage is generally good, especially in the upper and middle portions. Also, in the narrow upper end mountain and valley and canyon breezes are naturally strongest and most efficient in stirring and warming up the air on frosty nights. So that Palisade, especially that portion close to the cliffs, is the earliest locality and the least likely to be injured by late spring freezes.

Outside the Grand valley the orchards are generally located on hillsides, sloping mesas or benches, or in narrow valleys, so that air drainage is usually good. For example, the fruit in the Paonia section is largely raised on the comparatively steep sides of the valley of the North Fork of the Gunnison river and in the narrow valley bottom, down which a wind usually blows during the latter part of the night and in the early morning, especially during clear weather.

Damaging spring temperatures are most likely to occur in the district when a high-pressure area of considerable energy advances in the rear of a low-pressure area across this part of the state from the northwest. If the high has advanced so far that the district lies well within it, local air drainage produces considerable differences in minimum temperature. But if the district lies in the region of circulation between the high and the low (particularly if the latter be vigorous and lie central over the southern part of the eastern slope of the Rocky mountains), temperatures will be more nearly uniform, and mountain and valley and canyon breezes are likely to be weakened or entirely counteracted. If the center of the high pass some distance north of the district, some cloudiness may be expected (especially if there be a low over Arizona), and temperature fall will be retarded. It has been found that there is no useful relation from the viewpoint of the forecaster, between the evening dew-point and the minimum temperature the following morning; although the quantity of moisture in the air affects radiation and hence the fall of temperature. The minimum temperature on an April morning at Grand Junction is usually about five-eighths of the maximum temperature of the preceding day. If the air be very clear, still and dry, the minimum will be lower than the above relation indicates.

E. S. Nichols,
Local Forecaster, U. S. Weather Bureau.

METHODS AND ORGANIZATION IN FROST FIGHTING

P. J. O'Gara.

Efficiency of Present Methods

The present methods of frost prevention by means of fires and smudges, using the various types of oil pots and heaters, are by no means perfect. Perhaps in time we will have some method of orchard protection that is better than the oil pot now in use. It must be understood at the outset that the orchardist cannot afford to equip his orchard with apparatus of too costly a nature; it must be simple, or at least easily workable, and not too delicate for practicable use.

The protection of orchards from frost injury is not an experiment in Rogue River valley. A perusal of the records will show that the experimental stage in practical orchard heating has passed. A glance over the valley will show the large commercial orchards equipped with fuel pots for burning crude oil, distillate and coal, while others are protected by means of wood, which has proven very successful. A commercial orchardist who has for the past four seasons saved his crop, valued at more than $1,000 per acre, is not much in need of advice. If the cost of saving his crop is well below the maximum it would seem that, for him, his method must be the best. During the 1911 season of frosts the Rogue River valley orchardists did not experiment. In saving the crops from frost injury a safe approximation would put the number of fires used at fifty thousand. A large number of these were fuel pots burning crude oil and distillate, but there was also a very large number of wood fires, which, though somewhat clumsier to handle, were none the less effective in obtaining the desired results, namely, saving the crops from damage.

Types of Orchard Heaters

In a commercial way, the types of pots used are the Fresno, Bolton and Hamilton. The Ideal coal pot was in use during the 1910 and 1911 frost periods. It is not the object of this article to discuss the relative merits of the different types of pots. The writer, however, has contended that the simplest type, which of course, will be the least expensive, is the one which will grow in favor with the fruit growers. A lard pail type is just as efficient as the Fresno pot with its row of holes near the upper rim. The Bolton pot has one disadvantage with respect to the arrester, or partial cover, which is placed over the mouth of the pot. No doubt in burning 28-degree test distillate this type of pot will work very nicely, but with crude oil or slop distillate the heavy coating of soot will tend to clog the openings and, in the course of a night's use, will have a marked effect in reducing the efficiency of the pot. It may even clog so much as to put out the flame. However, this pot, used open and without arrester, may be equal to the Fresno or lard pail type, and has proven so in actual test, since, burned that way, it is practically the same as the other two types. The Hamilton heater is so arranged as to increase or decrease the burning surface so as to regulate the amount of heat. This pot, which is made in the form of a rectangular trough, is not so saving of fuel as might be supposed, since there is often a tendency for the flame to burn back of the apron which hangs downward from the sliding cover, and which regulates, or is supposed to regulate, the amount of fuel burned. The Ideal coal heater is designed to hold 25 to 30 pounds of coal, and is very satisfactory so far as heating is concerned, but the fact that a great deal of time is required to lay the fires, or prepare the heaters, is somewhat against their use. There are a large number of heaters on the market, each one with its particular claim for efficiency; but as yet, with the fuels we have, it is a question as to what superiority one type may have over another. So far there has been no real efficiency test made in any part of the country where heaters have been used side by side under absolutely like conditions. It is the young orchard, which covers only a small part of the ground and traps little heat, with the fruiting area very low down near the ground, that is difficult to protect from frost injury. A test in such an orchard would really be worth while.

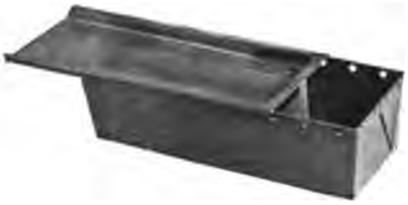

Fig. 1. Hamilton Reservoir Type of Orchard Heater.

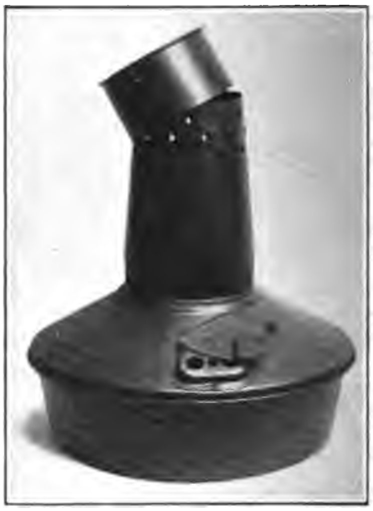

Fig. 2. Oil Stove Type.

Fuels

The fuels used are crude oil, 28-degree test distillate, coal, wood (old rails and cordwood), straw, sawdust and manure, the latter being mainly used to produce a dense smudge. One of the greatest difficulties in the use of crude oil and slop distillate is the presence of water, which tends to extinguish the flame or cause the pots to boil over. The presence of water in crude oil is due to the fact that water is forced into the rifled delivery pipes as a jacket so that the oil will flow readily. Crude oil cannot be forced through long lines of pipe without this water jacket. Outside of the fact that the crude oil often contains water, it has a very great tendency to deposit large amounts of soot on the trees, as well as tending to clog certain types of pots. Besides, a very large amount of residuum is left behind so that a second or a third filling will so coat the sides and bottom of the pot that it will hold much less oil in future fillings, and will, therefore, burn for a much shorter period. For instance, a pot that will hold one gallon when clean will not hold more than three-fourths of a gallon after having been burned two or three times. This is a very serious defect, and one that cannot be overlooked. The crude oil from the wells of the Pacific coast is unlike that of the East or Middle West in that it has an asphaltum base. No matter what the type of pot, a heavy asphaltum oil cannot be perfectly burned; that is to say, combustion is not complete. The heavy asphaltum base requires a much larger amount of oxygen than even the best type of pot can furnish, hence the large amount of residuum left on the sides and bottom of the pot. The oils of the East have a paraffine base and burn much better. At this time, however, it would seem impossible to bring this oil in so as to compete with the Pacific coast product. The freight charges would bring the price up to a point where its use would be prohibitive.

The distillate burns readily, leaves but very little deposit and does not tend to produce so much soot. This is what is called the 28-degree test. Its cost to the growers is very much above that of crude oil, and, therefore, was not used in 1911. The distillate used is known as "slop" distillate, and, although it was supposed to test 23 degrees, it has been found to test about 20 degrees, or perhaps a little more. This slop distillate proved to be very little, if any, better than the crude oil, since some of it contained water; and, besides, it tended to produce a great deal of soot. The amount of residuum left in the pots was in many cases nearly equal to that left by the crude oil. Both the crude oil and the slop distillate will eventually be replaced by a better fuel. We will either use a distillate, such as the 28-degree test, or the lighter paraffine oils of the East. The cost of crude oil laid down at Medford is about four and one-half cents per gallon, and that of the slop distillate six and one-quarter cents per gallon. The 28-degree test distillate, in 1910, cost the growers approximately nine cents a gallon. The greatest element of cost in obtaining these crude products is the high freight charge. Crude oil at the wells in California is worth scarcely two cents a gallon, and the distillates, which are refinery products, do not cost more than twice that figure.

By some of the fruit growers wood has been used for several years. That wood has been effective in preventing frost injury even when the temperature may run very low is proven by an examination of the orchards where wood was properly used. In connection with the wood one grower used a small amount of crude oil, which he threw upon the wood fires ranged along the east side of the orchard so as to produce a dense smudge just before sunrise. In the Hollywood orchard wood was also used for its heating effect, and the dense smudge was produced by adding quantities of stable manure to the wood fires. An examination of the orchard showed that the method worked very well. In other orchards the same scheme of using wood and manure was carried out, and excellent results were obtained. In some very small orchards sawdust and shavings, put into large paper sacks and saturated with crude oil, also proved to be quite effective. These fires burned from six to seven hours, giving off a considerable amount of heat and a very dense smudge.

Methods of Lighting

The methods of lighting the different fuels are not difficult. With crude oil and distillate a small amount of gasoline or kerosene, squirted from an oil can onto the surface of the oils, was easily ignited by a torch. In most cases the torches were home-made affairs, but were none the less serviceable. A man could easily light the pots as fast as he could walk. The cover on the pot was quickly thrown off, a few drops of kerosene or gasoline spilled on the surface of the oil and the torch quickly applied; this is the work of but a moment, and scarcely needed a stop on the part of the operator. In order to ignite the wood it is necessary to pile it in a particular way. Fine material is not absolutely necessary if the wood is dry. A kerosene can and a torch are all that is needed. A small amount of kerosene spilled on the wood, which is piled "dove-tail" fashion, and the torch applied will easily start it. During the past season of frosts some difficulty was experienced in lighting the wood on account of the fact that during the week previous there had been a heavy precipitation amounting to about 1.27 inches. However, this exigency was overcome by using kindling and a little more kerosene and some crude oil. In using wood the particular thing to keep in mind is that it should be dry. Frost conditions are almost certain to follow a heavy rain, and this was particularly true during this season.

Planning the Frost-Fighting Campaign; Number of Pots or Fires per Acre

The work of planning the frost-fighting campaign really begins the previous fall. If crude oil or distillate is the fuel to be used the pots must be purchased so as to be on the ground not later than the last week of March, even though frosts do not usually occur before the first week of April. The fuel oil is also ordered in tank cars of 6,000 to 10,000 gallons each, and upon delivery is emptied into large storage tanks on the ranches. These tanks are usually of concrete, and are placed upon an elevation so that the work of unloading the delivery wagons, as well as the subsequent filling of the tank wagons for delivery to the pots in the orchard, is effected by gravity. Pumping crude oil is rather an impossible task, or a difficult one at best, especially when it is cold. Distillate is easier to handle, but the gravity method of handling it is much quicker and saves a lot of work. The method of filling the pots is usually by means of a large hose attached to a gate valve on the delivery tank. Another method is to use large buckets with which to fill the pots. When this method is used the hose is dispensed with, and only a large gate valve or molasses gate is used. Six men working eight hours can easily fill 2,000 pots. The number of pots to be used per acre will vary within wide limits. Large spreading trees, with the fruit borne not lower than four feet from the ground, may easily be protected from the most serious freeze we have experienced during the past four years by using sixty-five to seventy pots per acre. However, it is to be understood that the sides or outside rows should be reinforced by at least two rows of pots. This is especially true of the sides of orchards in the direction of the prevailing wind. However, it is a good plan to reinforce all sides so as to meet any emergency. During the 1911 season sixty-five pots burning slop distillate saved the Potter and Goold pear orchard when the temperature outside of the orchard registered 20 degrees by a tested thermometer. The results in this orchard are so clear that there is no mistaking the effectiveness of systematic orchard heating. A few pear trees of the same variety standing about ten rods outside of the heated area lost their entire crop.

The number of pots to be used will depend upon the geographical position of the orchard, its elevation, and the size and height of the crop bearing portion of the trees. In a young orchard of perhaps four to eight years of age it will take two or three times as many pots as in an old orchard with spreading limbs almost touching each other and effectively trapping the heat. A perfect knowledge of the frost possibilities of any particular tract will guide one as to the amount of protection necessary. It would be safe to say that from 150 to 200 pots will be needed in very young orchards situated in what are known as "cold spots." Every orchardist knows, or should know, where these spots are. When wood is the fuel to be used it should be secured early, and must be dry. Most of the firing done by wood has been with old rails which were well seasoned and burned without difficulty. Cordwood has also been used to a somewhat less extent, but, nevertheless, with entire satisfaction. Wood is very clumsy and much in the way, and there is no doubt that its use will be abandoned in the near future. Some growers, however, are of the opinion that wood is the best fuel, and it is quite probable that for small tracts its use will be continued. There is really no difficulty in handling it if properly placed, but for large tracts I would rather think its use to be quite out of the question. The element of time consumed in placing it as well as the space it takes up in the orchard, thus interfering with cultivation, argues against its use. The number of wood fires necessary for large trees may be all the way from 25 to 50. The fires should not be large, since large fires tend to produce convective air currents and may be more harmful to the orchard as a whole than the same number of small fires. In most orchards it was found that the temperature could be raised six to ten degrees. Manure, sawdust and rubbish are used mainly to create a smudge, and are of practically no value in raising the temperature. In using wood these materials are often quite an additional help in holding the heat generated by the burning wood. It often happens that the temperature cannot be kept above the danger point; if this happens toward morning the smudge is beneficial in protecting the frozen blossoms and fruit from the morning sun, which would tend to thaw them too rapidly. It is not the freezing of the fruit that causes the injury; it is the thawing. Blossoms may be frozen solid for several hours and not be injured if thawed out very slowly. Freezing causes the water to be abstracted from the cell protoplasm. The protoplasm has taken this water up from the soil very slowly. If the water which has been abstracted from it can be returned very slowly the cell will recover its former activities. No matter what fuel is to be used a plentiful supply should be distributed in the orchards. Even if fifty pots will do the work it is better to have one hundred or more for each acre even in an orchard of old trees. The same may be said of wood. It is only necessary to light as many fires as will keep the temperature above the danger point. It is as great a mistake to light too many fires as it is to light too few, for the reason that burning unnecessary fuel may cause a shortage at a time when lack of fuel would mean a total loss. Once the temperature goes very much below the danger point it is hard to raise it, and if this happens very near sunrise a smudge dense enough to protect the frozen blossoms may be hard to secure or to keep hanging over the orchards. It is best to take no chances.

Thermometers and Frost Alarms

Good thermometers should not be overlooked, and no fewer than two or three per acre should be used for the best results. These instruments should not be the very cheap kind, although it is not advised that they should be very expensive. All thermometers should be tested and the correction for the different points on the scale carefully marked so as to be easily read. A thermometer with its correction is just as good as one that reads absolutely true. As a matter of fact, the very best thermometers are not accurate, and must have corrections made for different parts of the scale. For the orchardist, it is usually sufficient to know within at least half a

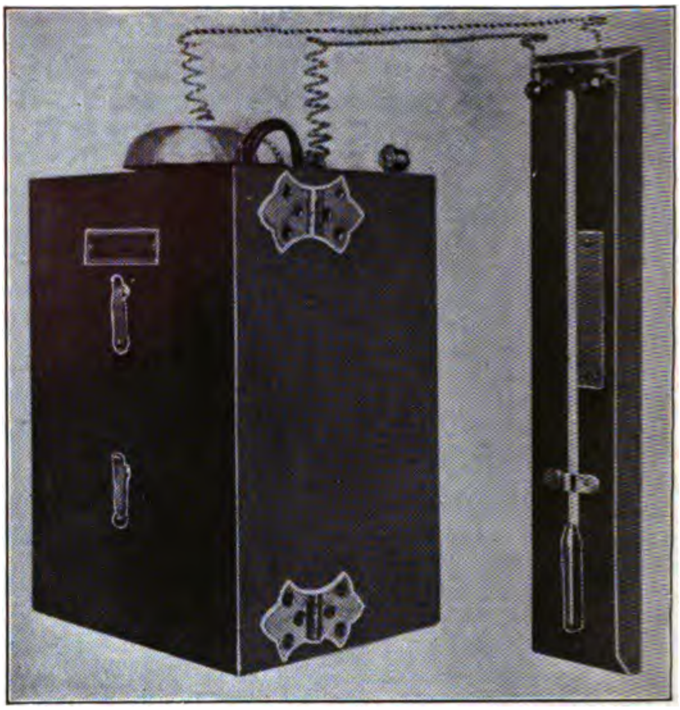

Fig. 3. Carbondale Frost Alarm.

degree of the correct temperature reading, since he is quite certain to keep on the safe side at all times. Besides the thermometers in the field, the frost alarm thermometer, which is designed to awaken one when a certain temperature has been reached, may be more or less advisable. Of course, all a frost alarm thermometer can do is to indicate that a certain temperature has been reached. It is usually made to ring at, say 33 or 32 degrees, and does not necessarily indicate that dangerous temperatures will follow. During the past the local forecasting station has indicated very nearly the hour when it would be necessary to fire as well as forecasting the possible temperature, so that with this in mind those who had no frost alarm thermometers got along very well with a good alarm clock. It would be a serious mistake to begin lighting up without knowing whether or not the temperature would go below the danger point; this is where the local forecaster's work is of greatest value.

Physics of Orchard Heating

In all that has been published no figures have been given to show what a certain quantity of fuel will do under actual conditions. Of course, this cannot be accurately stated, but we can give what we might expect under set or ideal conditions. We will take as an instance the protection of a pear orchard with the trees set 25 feet apart on the square. With the trees in good bearing the maximum height at which fruit is borne is not more than 15 feet, and is usually much below this. We will consider each pear tree as growing in a cubical space which, under normal atmospheric pressure at our elevation above sea level (1,400 feet) and at a temperature of 32 degrees Fahrenheit, contains, in round numbers, 600 pounds of air. If this space contained 600 pounds of water it would require 600 British Thermal heat units to raise the temperature through one degree Fahrenheit, but since the space is filled with air under the above conditions it will take only one-fourth as many heat units to raise the temperature one degree within such space. If one oil pot is provided for such a space, that is, one pot per tree, we will have 70 pots per acre. Each pot will have to take care of 600 pounds of air. Most of the crude oils used as fuels for orchard heating in this district average nearly eight pounds per gallon, and it has been found by laboratory test that a pound (one pint) has a calorific, or heat value, of about 18,000 British Thermal units. Some oils test higher, some lower. In burning tests in the field under actual frost conditions it has been found that for the lard pail type of pot, such as the Bolton, with or without perforations in the upper rim, two pounds of oil are consumed per hour. Naturally, the oil consumption is greater when the pots are first lighted, and this is also true where there is considerable air movement. Of course, combustion is not perfect, hence the total calorific power of the oil is not utilized. However, since we are dealing only in round numbers we will suppose that combustion is fairly complete. Then two pounds of oil will give off 36,000 heat units per hour, or 600 per minute. Now, since the cubical space occupied by one pear tree contains about 600 pounds of air at our average pressure and at a temperature of 32 degrees, it means that each minute 600 heat units are expended on 600 pounds of air, or sufficient to raise the temperature of this mass of air through four degrees Fahrenheit. We have not taken into account the small amount of water vapor present under frost conditions, as this would not appreciably affect the calculation. It is supposed, of course, that the air is not in motion, and that there is no radiation of heat beyond the imaginary cubical space occupied by the tree. In actual practice we know that radiation does take place, and that there is usually some air movement. Of course, this is offset to a very great extent in old orchards by the trapping of the heat and the braking effect on wind currents, due to the extended branches, but in young orchards, covering but a small ground area, air movement and radiation are practically the same as in the open. There is one thing to be said, however, under our conditions. Upward radiation of heat is not so great as one would suppose. During the past four years a large number of observations have shown that the temperature of the atmosphere during a freeze rarely reaches the danger point at a height of 15 to 20 feet above the level of the valley floor. Since this is true, there would be no tendency for heat to be radiated from below into this upper stratum of warmer air—in fact the heat movement would rather be the reverse, that is, downward. As previously explained in another part of this article, frosts which occur in this valley are due to depression rather than elevation. It is the cold air coming from very high elevations in the surrounding mountains that flows downward into the valley floor, tending to push the warmer air upward. For a while radiation from the ground, which has taken in heat during the hours of sunshine, tends to warm this cold air. But to return. We have shown that with no wind and with one oil pot for every pear tree the temperature may be raised four degrees per minute within the calculated space. But if the air moved only 100 feet per minute, or a little more than one mile per hour, the temperature could never rise more than one degree above the temperature of the incoming cold air. At four miles per hour it could rise but one-fourth degree. This would be true only in the outside tree rows, on the side from which the air movement comes. For all the rows beyond the outside row, some of the heat units generated in the first row would be added to the heat generated inside. This interesting calculation shows that an orchard in the form of a solid square would not be so difficult to save from frost injury as one of the same area of only a few rows. During the past four seasons this has been demonstrated in several of our orchards. In the Potter and Goold orchard the main body of pears has easily been saved when temperatures ran as low as 20 degrees outside, while two rows of pear trees extending beyond the main body of the pear orchard but surrounded by apple trees fully larger lost most of their crop, although protected by a greater number of fires. No orchard heating device on the market effects perfect combustion of crude oil or distillate, therefore the theoretical figures given above are hardly approached in practice. In some tests carried out in this district the beneficial results of certain devices did not show up when it came time to harvest the fruit. The time to tell whether orchard heating has been successful or not is when the fruit is picked and brought to the packing house. Just to make fruit stick upon the trees is not protection. A misshapen or frost marked fruit is not commercial either for fancy box trade or for the cannery. Canneries do not want badly frost marked pears, as the waste is too great. In the above calculation we have considered only crude oil, but practically the same figures will apply to all the heavier distillates. It might be well to mention something in regard to other fuels we have used in this district. A pound of dry pine wood, under perfect combustion, will generate about 6,000 heat units. A pound of oak contains practically the same number of heat units. Coal, under the same conditions, has approximately 12,000 heat units. The average weight of a cord of pine is about 2,000 pounds, and that of oak is about 4,000 pounds. These figures are, of course, only approximate, but they will serve as a basis for calculation in case anyone should desire to use wood or coal for orchard heating purposes. The use of wood and coal has been discussed in previous articles, also in United States Farmer's Bulletin No. 401, which may be obtained by addressing a letter to the United States Department of Agriculture, Washington, D. C.

Meteorological Instruments

Wherever it is found necessary to protect orchards from frost injury each fruit grower should provide himself early in advance of the season for firing not only with fuel, pots or other heating apparatus, but also with a sufficient number of thermometers. It is also advised that each fruit grower should have a good maximum-minimum theremometer. A dew-point apparatus or psychrometer for determining the dew-point temperature, accompanied with tables, would also be a valuable part of the equipment. The dew-point apparatus is simply two fairly good thermometers fixed together, with one of the bulbs covered with linen. A string tied into the rings of sufficient length to whirl the instrument completes it. In using the instrument, wet the covered bulb and whirl rapidly so that evaporation will take place from the wet surface. When the mercury in the wet bulb thermometer cannot be lowered any further it should be read simultaneously with the dry bulb theremometer. The readings are referred to tables (See U. S. Farmer's Bulletin No. 401) which give the dew-point temperature. The dew-point temperature, when found in the early evening, is usually in close agreement with the minimum temperature the following morning, providing the sky remains clear and there is no wind. This is true during only a part of the year. The following data taken from the records made by the Medford United States Weather Bureau station for the years 1909, 1910 and 1911 will show that the above statement holds good. It will be noted that the dew-point temperatures observed, both when frosts occurred and when they did not, agree fairly well with the minimum temperature:

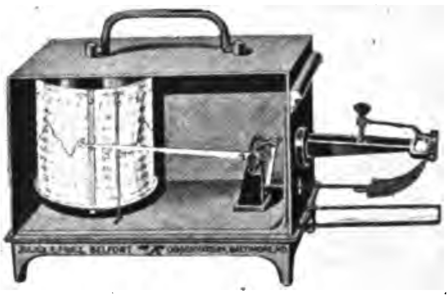

Fig. 4. Thermograph, or Self-Registering Thermometer.

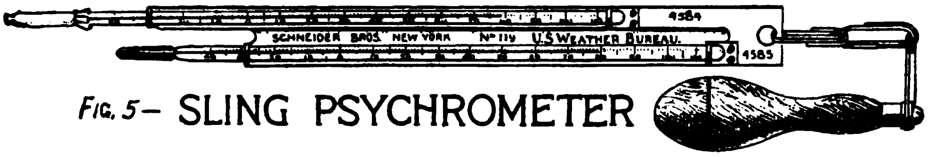

FIG. 5— SLING PSYCHROMETER

Year	Date	Time	Dew-point degrees	Temp. during night degrees
1909	April 19	....6:45 p. m.	29	29
1910	April 3	....6:30 p. m.	27	27
1910	April 9	....6:30 p. m.	44	44
1910	April 11	....6:30 p. m.	41	40
1910	April 13	....6:30 p. m.	29	26
1910	April 25	....6:30 p. m.	42	44
1910	May 2	....6:30 p. m.	40	42
1911	April 14	....6:30 p. m.	23	22
1911	April 25	....6:30 p. m.	41	43½
1911	April 28	....6:30 p. m.	31	27½

These figures are taken at random from the records and represent pretty fairly all the data which have been recorded during the above years throughout the frost season. The minimum temperatures are for such nights as remained clear and with very slight air movement, which was from the south. An aneroid barometer is also a valuable instrument. By carefully noting the movement of this instrument one may readily learn to predict with more or less certainty the kind of weather to be expected. With the pressure high the chances are that frost may be expected and the reverse when the pressure is low. In making readings with all meteorological instruments there should be a set time for observations. Random readings, taken at odd times, are of very little value. A careful record will surely repay the observer many times for his trouble. It would be a very fine practice for each grower to be able to tell what were his maximum and minimum temperatures, barometer, wind direction and estimate of velocity, dew-point temperatures and rainfall for each day in the year. This data would not only be valuable to himself, but to the district as a whole. Lastly, whenever it is possible get the weather from the nearest United States Weather Bureau station. The local observer is usually better equipped to tell what weather conditions are likely to be expected and what emergencies are to be provided for than anyone else. He is also able to tell what temperatures are injurious to the several kinds of fruits through the season. Injurious temperatures are not the same for all varieties, nor are they the same for any one variety during different stages of its growth.

Fruit Garden

In all undertakings of this sort it is very important to have a clear and intelligent idea of what is to be done. There are so many matters which have to be adjusted to one another that the essential items are sure to be overlooked, unless the project is systematically developed. The garden-plan should be made as carefully as the plan for a house and with as much attention to detail as the architect gives in his finished drawings. Every tree and bush should be located and its species and variety designated. After this much has been done, it will be easier to decide on drainage, cultivation and management. Unless these things are done, all other questions are settled by guesswork.

There is no end of entertainment for winter evenings in this matter of making a design. Many families spend years of pleasant recreation in planning houses which they never build, but gardeners' plans are cheaper and just as interesting.

We all know that the common city lot, or suburban garden, is not an ideal place for fruit growing, agriculturally and geologically speaking. The soil is apt to be made up of ashes and the drainage secured by a varying admixture of tin cans and discarded umbrellas. While such soils do not appear under terms of high praise in the agricultural survey, they are not altogether impossible to the determined city gardener; and the first term in their utilization is that of drainage.

It may be difficult for a perfect ignoramus to tell by looking at a piece of land whether it is drained enough or not. Yet a good deal can be told by observation. If water stands in pools on the surface for any length of time after a rainstorm, it indicates that the drainage is poor. If the soil is left very hard and brick-like when it dries out after a rain, better drainage is required.

The best way to secure drainage where such treatment is required is by means of porous drain tiles. These must be furnished with some satisfactory outlet, either into the sewer or open ditch. They should be laid through the soil at a depth of two to four feet, and the branch drains in the small garden should be thirty feet apart.

Good drainage is essential to success with a fruit garden.

Preparation of the Soil

Considerable care will be needed to prepare an unsuitable suburban lot for a successful amateur garden. In many cases the city dweller or suburbanite is compelled to make the soil first. Perhaps he has to buy it. In case the place has no good soil on the surface, it will be necessary to get a supply, even though it has to be bought from contractors. For our purposes we need a strong, gravelly soil, without too much clay. If we can get surface soil containing vegetable matter, humus and loam, so much the better.

The best preparation to be given to soil comes through drainage and cultivation. The ideal way to prepare the garden is to spade it up deeply—just as deeply as possible. This work should be done early in the spring. Then the land should be planted with some crop which will make a vigorous growth. Cow peas, soy beans, crimson clover and buckwheat are the best crops, each one having its particular advantages. Any one of these will add humus and life to the soil. Suppose a crop of this sort has been grown the first year; it will be allowed to stand through the winter and will be plowed or spaded in the following spring. The second year the ground should be planted to some crop requiring high cultivation, such as beets, cabbage or potatoes. A liberal allowance of barnyard manure should be given, and the hoe and cultivator frequently applied. The third year the ground will be in excellent condition for planting. This program will be effective on everything except the most refractory soils. On better land the preparation may be reduced to a single year, and on good land the soil may be dug up and planted to fruit trees the first year.

Plant Food

Backyard lots are apt to be deficient in available plant food. There are usually enough chemicals in the soil to grow trees, but they are not accessible and digestible. The deficiency is to be made good with fertilizer. In beginning the garden, no fertilizer can be compared with well-rotted barnyard manure. This should be used liberally. A garden 50 feet square would usually be able to use two cords of stable fertilizer to good advantage at the beginning of its cultivation, and might have one cord annually for the first two or three years.

As soon as the work is well under way, soil in good condition, and the trees beginning to make some growth, the amount of barnyard manure should be materially reduced, or cut off altogether. At the same time, the amount of chemical fertilizer should be increased. For smaller gardens it will be found best to buy ready-mixed fertilizers, depending a good deal on the advice of the best dealers. Such dealers can supply mixtures suitable for fruit trees and are willing to give information regarding amounts to be used, times of application, etc.

Getting the Trees

Varieties to be planted should be selected, as far as possible, on the basis of the gardener's own taste, corrected only by what you are able to learn regarding their probable success in the locality. Of course, if you know nothing about the different varieties of peaches, plums or apples, you would better consult the expert, and, in this case, the professors at the agricultural college will give unprejudiced and reliable advice. The best nurserymen can be relied on in this way, also; since it is to their interest to supply only such trees and varieties as will succeed and please their customers. But avoid, always, at all times, the itinerant tree peddler.

In nearly all cases trees should be ordered in the fall, and they should be delivered and planted in the spring.

A great deal of superstition surrounds the practice of tree planting. Many persons imagine there is some hocus-pocus about it. In many of the horticultural books there will be found most elaborate directions, amounting almost to religious ceremonies, for the planting of trees. Much of this is unnecessary and nonsensical, as is shown by the fact that commercial tree planters do the work with low-priced, ignorant help, and still accomplish it very rapidly. I have seen a gang of four men, no one of them able to read Caesar, plant 800 trees in a day—and every tree grew. A very able American horticulturist has recently advocated a new and striking method of tree planting, which consists in cutting off all the roots and most of the top from every nursery tree, and inserting the stubs in holes driven in the soil with a crowbar. The most amusing thing about this proposition is that it succeeds admirably in most cases. Wherefore, let us say that young fruit trees may be planted with every prospect of success if the most ordinary common sense is exercised. Broken roots should be cut away, and the top of each tree should be liberally pruned before setting. Water or fertilizer should not be put into the hole with the tree roots. Under most circumstances, both should be omitted from the process altogether, though either one may be applied in small quantities to the surface about the tree after it is planted.

Management After Planting

In order to make the fruit tree succeed, constant and intelligent labor is required. The garden must be well tilled, especially during the early portion of the summer. Tillage ought to cease about July 10th in central latitudes. Trees ought to be pruned year by year. Several books have been written about pruning, and I hesitate to condense their information into a single paragraph. Some regular treatment, such as spraying, should be planned for the suppression of insects and fungus diseases. Information on such matters can be secured from books, or from experts, who may be consulted without expense. The annual supply of plant food is to be kept up. Where trees are grown in dwarf forms or on trellises, there is more or less training to be done.

Dwarf Fruit Trees

It will be quite wrong to pass over the subject of dwarf trees in the discussion of city lot fruit gardens. On all small places the dwarf trees are of great advantage. Their principal superiority in this case lies in the large number of them which can be put on a small tract. Dwarf fruit trees bear fruit exactly like the ordinary trees, and of the same varieties, such as Baldwin apples or Anjou pears. In size they may stand anywhere below the ordinary fruit trees, but, of course, for backyard gardens the smallest sizes are desirable.

These dwarf fruit trees are secured by budding or grafting the ordinary varieties upon diminutive stocks. For example, the smallest dwarf apples are grafted upon so-called Paradise stocks, these being simply very diminutive apple trees grown from cuttings. Dwarf peach trees are secured by budding the ordinary varieties on small slow-growing plum roots. Dwarf pears are secured by budding the pear scion upon quince roots. Unfortunately, the demand for such things is not great enough in this country to insure a constant supply. Dwarf pears and dwarf apples can be secured from leading American nurserymen, but it is almost impossible to get dwarf peach or plum trees without sending to Europe or propagating them at home. This business of home propagation is worth trying, however. It is quite as interesting as fruit growing itself, and is capable of furnishing liberal education to the boys, not to mention the girls.

Some other advantages of dwarf fruit trees will be fairly plain without argument. They bear fruit at a much earlier age than the ordinary trees, often yielding good crops two or three years after planting. The trees being small are easier to care for, easier to prune, easier to spray.

It must not be understood that it is cheaper to grow fruit in this way, or that the dwarf trees are to take the place of standard trees in money-making enterprises. We are talking of them now only as a first-class entertainment; but they do form an almost essential feature in the design of a city fruit garden.

Some Specific Suggestions

Our country is so large, and its climate and soils so diversified, that we cannot possibly lay out one fruit garden which can be adopted everywhere. Points to be kept in mind are: (1) that a considerable diversity of fruit should be put in every home garden; (2) that these should be chosen according to personal taste; (3) that due attention should be paid to the adaptability of all varieties to the soil and climate; (4) that varieties should ripen in succession; (5) that varieties of fine appearance and high quality be chosen in preference to those which are commercially successful.

Frank A. Waugh,
Amherst, Mass.
(Courtesy Woman's Home Companion.)

*Fruit Trees—Winter Killing of

About once in each decade, and sometimes oftener, a severe winter occurs in which an unusually large number of fruit trees are killed. An examination of the orchards after such winters shows many irregularities as to the extent of the injuries in orchards differently located and managed. Some varieties of fruits are uniformly less hardy than others, and the winter injury to these sorts may be traced directly to their greater tenderness. On the other hand, trees normally perfectly hardy in a locality may suffer serious injury or be entirely killed during such "test" winters, while other trees of the same varieties in the same orchard may escape injury entirely. During the prolonged cold winter of 1903-4 great losses were suffered by orchardists in the Lake Erie peach belt. Some orchards were entirely destroyed; others were apparently uninjured and came through the winter in a vigorous, hardy condition; and still others, while suffering severely, yet contained sections, rows or parts of rows, or individual trees that came through the winter uninjured.

Many theories were advanced by the orchardists as to the cause of these anomalies, and as many contradictions appeared. The theory of insufficient drainage, which might be advanced as the cause of the injury in one orchard, would receive direct refutation in the next. If an orchard on elevated ground escaped in one instance it might be partially or entirely killed in another. In order to learn the cause of these irregularities, the horticulturist of the Ohio Experiment Station and his assistants visited both injured and uninjured orchards in Catawba island and the peninsula of eastern Ottawa county, in Ohio, and made a thorough study of the matter, reporting the results of their investigations in a recent bulletin of the station.

Their investigations show that while a general or direct cause of the injury was, of course, the severe and long-continued cold, the specific causes of the varying degrees of injury were exceedingly numerous. Generally speaking, it was found that where the vitality of the tree or orchard had been lowered by any cause whatever during its previous history the chances of injury to the tree by the cold were by so much increased. Factors observed in different orchards which contributed to low vitality in the trees were an insufficient degree of fertility, a low physical condition of the soils, prevalence of San Jose scale, leaf

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* Compiled from Ohio Experiment Station Bulletin 157.

curl, peach tree borers, extremely dry condition of the ground in some sandy and gravelly ridges, "water-logged" soils, etc.

Injury on Bare Ground

There was a marked contrast in the extent of the winter injury on bare soils—soils given clean cultivation—and on covered soils. The bare soils froze deeper and the injury was much greater than on soils covered with a mulch or other material. The greater depth to which bare soils freeze in winter than covered soils was brought out in an experiment made at the station. A plat of peaches in an exposed situation was selected and a strip of sod 10 to 12 feet wide removed from one row, leaving the bare surface of the soil fully exposed to the cold. Another row alongside was left in grass which had been clipped and allowed to lie upon the ground. † When the sod was removed the ground froze to a depth of 18 inches, while under the thin sod covering of grass and weeds in the other row the ground froze to a depth of about eight inches. The trees in the bare ground "were very slow in starting into growth the following spring of 1904. All of the trees in this row were seriously injured by the cold, many large branches dying, while in one case the entire tree was so badly injured that but few leaves appeared throughout the season, and these upon shoots so feeble and slender that the tree might well be considered dead. Later in the season, however, some of the trees rallied slightly, though all showed a serious lack of vitality. The trees in the sod * * * did not suffer in the least degree—all making a healthy, uniform growth during the season of 1904."

Value of Cover Crops

The value of an annual cover crop as compared with clean cultivation was found in an orchard 18 years planted, one-half of which had been cultivated during the first half of each season and then sown to crimson clover, while the other half was given clean cultivation during the growing season. "Upon the clean culture area there was a much greater percentage of injury from the cold of the winter than upon the crimson-clover section. Where the clover crops had been grown and plowed down the trees showed remarkably healthy, heavy, dark-green foliage, contrasting sharply with the yellowish, sickly foliage of the clean culture plat." Another grower in the injured peach region stated that "not a single orchard or section of an orchard of which he knew, that had received even a light dressing of barnyard manure within the last year or two, had suffered noticeably from cold."

Injury in Scale-Infested Orchards

A 13-year-old orchard of 660 trees was found located on shallow limestone soil covered with a dense, heavy growth of bluegrass. The San Jose scale had wrought havoc in the neighborhood, but it had been kept under control in this orchard by spraying. As a result, not a tree in the whole block was killed by cold. Across the road from this orchard was another, located on similar soil and also in sod, but in which the scale had not been controlled. "The story is told in two words—entirely dead."

Injury from Leaf Curl

Another instance is cited in which an orchard was sprayed in the spring of 1902 for the control of the scale, with the exception of three rows through the middle, which were overlooked. As a result, the scale increased rapidly during this season on these unsprayed trees, and they were also attacked by leaf curl, which practically defoliated them. The whole orchard was sprayed in 1903, nevertheless the trees had been so weakened by the leaf curl of the preceding year that the good care given them in 1903 was unavailing, and every tree in the three rows was killed, while every tree on either side of them which had been sprayed came through the winter sound, vigorous and healthy.

Benefits from Banking Trees

A simple, easy, and very effective method of preventing winter killing of peach trees was observed in the orchard of one grower. Just before winter set in this grower hauled manure to the orchard, but instead of scattering it beneath the trees in the usual way he banked a very few forkfuls immediately around the stem of the tree. When the supply of manure ran out peat or earth was hauled into the orchard and banked around the stems of the tree in the same manner.

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† See United States Department of Agriculture, Farmers' Bulletin 202, p. 11.

"The results from the use of these materials were uniform, and, surprising as it may seem, every tree that received this simple treatment survived the winter without the least injury from cold, while the few trees and sections of rows left here and there unbanked and serving as 'checks' in the experiment died almost to a tree." Another orchard of some 500 trees a little farther to the west of this orchard, "which had received the same high culture and good care, with the exception of the simple banking process, was almost a total loss." The trees in these orchards were extremely vigorous and had made a rank growth, which made them peculiarly susceptible to injury by freezing.

Orchards in Sod

On the same farm trees on a piece of ground which was so stony that it could not be cultivated and which was kept in bluegrass sod, with a heavy mulch of coarse material, such as cornstalks, barnyard manure, etc., about the stems, according to the true "sod-and-mulch" method, came through the winter without injury.

These investigations bring out strikingly the necessity of such continuous and thorough cultural practices in the orchard as shall maintain the trees at all times in a vigorous, healthy condition. The fertility and vegetable matter of the soil must be maintained by the addition of manure or the growing of cover crops. Spraying to control insect pests and fungus diseases must be thorough and unremittent. Trees on undrained or very rich soil, trees weakened by over bearing or by borers, all alike invite winter injury. Cover crops and mulches protect the ground from deep freezing and resultant winter injury. Sod serves the same purpose. Banking up the trunks with a few shovelfuls of manure or earth appears to have a marked favorable influence.

Fruit as Food

Edible fruits show the greatest range in form, color, and appearance and are found in almost countless varieties; yet from the botanist's standpoint all our fruits are the seed-bearing portion of the plant. The edible fruits of temperate regions fall into a few groups—stone-fruits, like cherries and plums; pome fruits, like apples and pears; grapes; and berries, like strawberries, blackberries, and currants. There are several products, such as muskmelons, cantaloupes, and watermelons, sometimes classed as fruits and sometimes as vegetables, which, of course, would not belong to any one of these groups. Tropical fruits are not so easily classified, though the citrus family (oranges, lemons, etc.) includes many of the more common sorts.

There are a few vegetable products which are not fruits in any botanical sense, but which by common consent are included in this class of food products since their place in the diet is the same. The most common of these products is rhubarb, and there are few uses of fruit which the acid rhubarb stalk does not serve. Angelica stalks, which are candied and used for making cakes and confectionery, are much less common, though the total amount used is large. It is certainly more natural to include preserved, candied, and crystallized ginger root with candied pineapple, candied cumquats and similar products than with any other class of food materials, and old-fashioned candied sweet flag root may also be mentioned in this connection.

Wild and Cultivated Fruits

In an account of the first Virginia colony it is stated that the Indians ate wild mulberries, crab apples, and huckleberries, but nothing is said of their cultivating fruits, though they raised corn and other vegetables. Wild fruits have been part of the diet of primitive man whenever obtainable, and no one can say with certainty when wild varieties were first cultivated, but it must have been early in the history of the race, since such fruits as apples and pears have been under cultivation so long that the varieties now grown have scarcely any resemblance to the very small, woody, inferior fruit of the wild parent. As a country becomes more thickly settled, less and less reliance can be placed on wild fruits, and the market gardener and fruit grower become of increasing importance. In the United States, strawberries, blackberries and raspberries are examples of fruits which are still eaten both wild and cultivated, and cranberries have so recently come under cultivation that many persons still think of them as a wild fruit. Huckleberries and blueberries are practically unknown, except as they grow wild, though attempts are now being made to bring the blueberry to greater perfection under cultivation. Among little known wild fruits elderberries and scarlet haws or thorn apples, to give them their New England name, may be mentioned. Both are used for jelly making to some extent and the former for other purposes also, but as yet neither is considered as of much importance.

It would be difficult to say why some fruits which are considered to be fairly palatable and equal to others which are generally eaten have obtained so little popularity. For instance, both wild and cultivated mulberries have long been known and prized by many, but are perhaps unknown to the majority of persons and very little used. In the same way the medlar, a fruit closely related to the apple and common enough in parts of Europe, is almost unknown in the United States, though it could be readily grown, if desired.

In some of our cultivated fruits, like the banana, seed is almost never found; in the case of others, for instance the orange, the seedless and seed-bearing varieties are both common; but in the majority of fruits seeds are present in greater or less abundance. It has been said that seedlessness is a result of long continued cultivation, but it seems more probable that the seedless forms are due to the propagation and cultivation of natural sports without seeds. Seedless sports are by no means uncommon in wild fruits. Thus the native American persimmon is now and then found bearing seedless fruit, and such a form could be perpetuated by horticulturists, if need be. The seedless navel orange has been propagated in recent times from a seedless sport, and it seems very probable that bananas, though the wild forms are commonly full of seeds, were propagated from a seedless sport in times too remote for record. Indeed, it may be said that there is an almost universal tendency to cultivate and perpetuate varieties in which seeds are few in number or small in size, and quite naturally, since such fruits are more convenient to use and contain a higher proportion of nutritive material in a given bulk.

In general, it is true that size, yield, color, flavor, texture, and chemical composition are modified by cultivation.

The commercial fruit grower, of course, desires a fruit of good appearance, having satisfactory shipping and keeping qualities, and too often the consumer is satisfied to accept a product in which such qualities predominate. Discriminating purchasers, however, will insist on good flavor, texture and cooking qualities as well, and such demands should be more often urged in order that quality may replace appearance as a standard in cultivating fruit for market.

Market Conditions and Fruit Supply

The fruit market has been very greatly modified and extended by improved methods of transportation and storage. A man need not be very old to remember the time when, at least in the Northern states, bananas were a comparative rarity outside the large cities, and oranges and lemons, though common commodities, were rather high in price. In the summer there was an abundance of the common garden fruits, but in winter apples were practically the only sort which was at all plentiful. A few years have witnessed a great change, and now there is hardly a village so small that bananas and other Southern fruits can not be purchased at reasonable prices. In Europe the situation is much the same. Such quantities of bananas are now taken to England and sold at such reasonable rates that they are sometimes spoken of there as the poor man's fruit. At the present time there are a number of fruits, such as avocados or "alligator pears," mangoes, and sapodillas, which are fairly well known in our large markets though seldom seen in the smaller towns. The enormous development of the fruit growing industry in California and Florida, which includes the products of both temperate and warm regions, as well as the possibilities of supplying the Northern markets with tropical fruits from Porto Rico and Hawaii, makes it probable that within a few years the avocado, the mango, and other tropical fruits will be as well known as the pomelo or the pineapple.

Improvements in transportation have also materially lengthened the season of many fruits, such as strawberries, which can not be stored for any considerable period. Florida and the Carolinas now send their berries to Northern markets months before the home-grown crop can be expected and several weeks before that from tidewater Virginia or New Jersey is ripe. As an illustration of the effect of improved methods in shipping fruit, it may be mentioned that melons from the south of France, hothouse peaches from Belgium, and peaches, plums and other fruits from South Africa are now sent to our American markets in winter. The introduction or origination of new varieties of fruits also prolongs the season. As an instance may be cited the Peen-to peach, a Chinese variety which can be successfully raised in Florida and Texas, and which is found in our Northern markets in early spring, though at present at prices which clearly make it a luxury. Furthermore, improved methods of culture and transportation have extended the area planted to old and well-known varieties.

Color and Flavor of Fruits

Fruits, like leaves and flowers, owe their varied color to a number of chemical compounds, the green to chlorophyll (the characteristic coloring matter of green leaves), the yellow to xanthin bodies and other yellow pigments, and the blue and red to solutions in the cell sap of complex coloring matters which have in most cases been isolated and classified. Several coloring matters are often present in combination and give rise to the great variety of shades which different fruits present. In white fruits coloring matter is absent from the epidermis and the cells are said to be filled with air. As fruits develop, mature, and deteriorate, the coloring matters present undergo marked chemical changes, and color is one of the most common means of judging of ripeness.

Attractive color has a decided effect on market value, and the public demand varies greatly in different regions. Thus, a yellow or russet dessert apple is demanded in the French market, while in many parts of the United States the red apple has the preference. A faded, dull color is often an indication of staleness; strawberries and raspberries which have been kept too long have little of the brilliant color of freshly gathered fruit. That fruit colors in general are not very permanent is shown by the way the color deteriorates on long-continued cooking or fades when canned and preserved fruits are exposed to the light.

In preparing such fruits as plums, peaches, etc., for the table, the skin may be readily removed without injury to the flavor by first immersing them for a short time in boiling hot water. A silver knife should always be used for paring apples, pears, and other fruits, as if a steel knife is used the acid of the fruit acts on the iron of the knife and frequently causes a black discoloration, and there is also very commonly a noticeable metallic flavor. If pared or cut fruit is exposed to the air, it rapidly turns dark in color, owing to the action of oxydases, as some of the ferments normally present in fruits are called, upon the tannin or other readily oxidizable bodies which are also normal fruit constituents.

In the same way the brown color of the bruised spots in apples is caused by oxidation by means of the oxydases present in the fruit of the tannin in the crushed cells. Such bruised portions contain a larger proportion of starch than the rest of the apple because the tannin hinders the transformation of starch into sugar.

In investigations carried on at the Oregon Agricultural Experiment Station with a view to preventing the discoloration of evaporated fruits and vegetables, it was found that treating sliced apples with a weak solution of common salt (1 to 2 per cent) resulted in a product which was very bright and white and of better appearance than that obtained by the well-known domestic method of treatment with cold water. It seems probable that the Oregon method may find application in the household.

Fruits owe their flavor in considerable degree to the sugars and the malic, citric, and other acids which they contain, but the flavor which is so characteristic of different kinds is almost entirely due to ethereal bodies. The amount present is often too small for determination by the usual chemical methods. However, in many cases these flavor-giving bodies have been studied and their chemical nature is known.

The flavor of strawberries has been shown to be dependent in part at least upon the presence of a volatile oil with pronounced strawberry odor which is found in small proportions in the extracted fat of the dried berries. Recent German investigators* have identified the compound ethers which give bananas their characteristic flavor.

With the orange and other citrus fruits the oil found in the skin has a very characteristic odor and flavor which are always associated in our minds with the flavor of the fruit. Obviously, the small amount of these bodies of pronounced odor and flavor can not materially modify the nutritive value of fruits, but they are of great importance in considering the place of fruit in the diet, as they are very largely responsible for its attractiveness and palatability. There is no doubt that we all eat more readily the foods which please our palate than those which are of indifferent flavor, and there is every reason to believe that the foods which please are actually digested more easily than those which do not, since they stimulate a normal and abundant production of digestive juices.

Composition of Fruits

Determining the proportion of water, protein, fat, carbohydrates (nitrogen-free extract and crude fiber), and ash in fruits as in other foods furnishes a convenient basis for pudging of their relative food value. It is quite common for chemists to determine, instead of their proximate constituents, the proportions of the different nitrogenous bodies present, as well as the amounts of the different sugars, etc., which in the ordinary method of analysis are grouped with the other carbohydrates.

The more detailed analyses are of great interest and value for many reasons, but with our present knowledge it seems fair to assume that the various sugars and starches, for instance, have the same nutritive value, and so a knowledge of the total quantity of these bodies present gives very satisfactory data for estimating the food value of the group.* Very many analyses and studies of fruit and fruit products have been made by chemists of the agricultural experiment stations, as well as by the different Bureaus of the Department of Agriculture. Table 1 summarizes a large amount of such data and shows the composition of fresh, dried, and preserved fruits and fruit products, and for comparison the composition of a few other foods as well. In this table and the discussions which follow, attention has been given especially to the fruit of northern and temperate regions and no attempt has been made to summarize the considerable amount of data available regarding tropical fruits, except some which are grown in the United States or which are fairly well known at least in the larger markets. Special studies of tropical fruits have been made by the California and by the Maine experiment stations, and the Bureau of Chemistry† of this Department has reported an extended series of investigations of such fruits and the jams and preserves made from them.

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* Deut. Essigindus, 1905, p. 81.

* An extended summary of the more detailed analyses of fruits and fruit products may be found in Konig's Chemie der menschlichen Nahrungs und Genussmittel. Berlin, 1903, volume 1, fourth edition, pages 820-895.

Most of the fruits and fruit products included in the table are too well known to need description. Of those which are less familiar, the avocado or "alligator pear" is a green or purple fruit not unlike an egg plant in appearance. The portion eaten is the pulp which surrounds the single large seed. In texture it is soft and somewhat like butter, and to this quality it doubtless owes the name "midshipmen's butter," given to it in the days of sailing vessels. The avocado is eaten in a variety of ways, but is most commonly served as a salad. This fruit has a delicate, almost nut-like flavor, and is every year becoming more popular. Earlier publications‡ of this Department have discussed the avocado at length and described its cultivation and uses.

The fruits of several sorts of cactus are very commonly eaten in Mexico and other regions where cactus is abundant, and are common though less well known in New Mexico and the Southwest. Under the name of prickly pear or Indian fig fresh cactus fruits, particularly the oblong, oval, yellowish or reddish fruits of *Opuntia ficus indica*, showing here and there characteristic tufts of fine spines or bristles, are occasionally seen at certain seasons of the year in large fruit shops. Cactus fruits may be used for jam making and in similar ways. A rather hard solid preserve or "cactus cheese," which may sometimes contain nuts, is a Mexican sweetmeat.

Many varieties of the guava, a very aromatic tropical and sub-tropical fruit, are grown in the warmer regions of the United States, and its uses are so varied that it is often said the guava occupies much the same place in cookery in the Tropics as the apple in northern regions. The fresh fruit is seldom seen outside the regions where it is grown, but guava jelly and guava paste are common commercial products, and have been popular ever since the days when the West India merchantmen brought these delicacies, preserved tamarinds, and oranges and lemons to our northern markets as well as such staple goods as sugar and molasses.

The roselle or Jamaica sorrel is the fruit of a widely distributed tropical hibiscus which is grown extensively in California and Florida. The fruits somewhat resemble okra in form, are of a dark magenta color, and have an acid flavor much like that of cranberries. They are used for jams, jellies, etc.

The Surinam cherry is the fruit of a South American tropical shrub now grown to a limited extent in Southern Florida and California. It is about the size and shape of an ordinary cherry, and owes its common English name to this fact. The fruit is bright red in color, and has a sharp but pleasant acid flavor. The Surinam cherry is used for jelly making, etc., but is seldom a commercial product.

The loquat, commonly though incorrectly called the Japan plum, is grown to a considerable extent in the southern United States. The small, yellowish, plum-like fruits are almost translucent when ripe, and are covered with a downy fuzz or bloom. The pulp is soft and tender and quite tart until fully ripe. The flavor is distinct and agreeable. Loquats are used both raw and cooked, and both fresh and preserved fruits are commercial products.

The sapodilla, a tropical fruit which thrives in regions like the warmer parts of Florida, suggests a good-sized russet apple in appearance, but when broken open is quite different in character, as it contains a number of rather large flat brown seeds embodied in a tender brownish white pulp. The flavor is characteristic, and to some palates suggests a combination of a pleasant mild acid with caramel or brown sugar. The sapodilla is a not uncommon commercial fruit in large fruit shops.

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† United States Department of Agriculture, Bureau of Chemistry Bulletin 87.

‡ United States Department of Agriculture, Bureau of Plant Industry Bulletin 77; Farmers' Bulletin 169.

Perhaps no fruit of the Tropics is more often discussed than the mango, some persons being exceedingly fond of this juicy aromatic fruit while others are as outspoken in their dislike. There are countless varieties of the mango, and many of them have a rank turpentine-like flavor, and are very fibrous. These qualities are not apparent, however, in the best varieties, which are of very delicate flavor and very palatable. The fruit is cooked in a variety of ways, being a staple article of diet in the Tropics, and is also eaten fresh. Some difficulty is experienced in shipping mangoes, as the flesh is very juicy and tender, but they are occasionally found in market at least as far north as Washington, D. C.

Table I

Average composition of fruit and fruit products.

Kind of Fruit	Refuse	Edible Portion						
		Water	Protein	Ether Extract	Carbohydrates		Ash	Fuel value per pound
					Nitrogen-free extract	Crude Fiber		
Fresh Fruits	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
Apples	25.0	84.6	0.4	0.5	13.0	1.2	0.3	290
Apricots	6.0	85.0	1.1	....	13.4		.5	270
Avocado	29.0	81.1	1.0	10.2	6.8		.9	512
Bananas	35.0	75.3	1.3	.6	21.0	1.0	.8	460
Blackberries	....	86.3	1.3	1.0	8.4	2.5	.5	270
Cactus Fruit	....	79.2	1.4	1.3	11.7	3.7	2.7	375
Cherries	5.0	80.9	1.0	.8	16.5	.2	.6	365
Cranberries	....	88.9	.4	.6	8.4	1.5	.2	215
Currants	....	85.0	1.5	....	12.8		.7	265
Currants (black) *a*	....	79.0	*b*.5	*b*.3	13.1	*a*6.1	1.0	370
Figs	....	79.1	1.5	....	18.8		.6	380
Gooseberries *a*	....	85.6	*b*1.0	....	......	*c*13.1	.3	255
Grapes	25.0	77.4	1.3	1.6	14.9	4.3	.5	450
Guava *a*	....	82.9	1.3	.7	8.0	6.6	.5	315
Huckleberries	....	81.9	.6	.6	16.6		.3	345
Lemons	30.0	89.3	1.0	.7	7.4	1.1	.5	205
Loquat	....	77.9	.2	....	20.2	.6	1.1	395
Mango *a*	*b*40.0	87.4	.6	.4	9.9	1.2	.5	220
Medlar *a*	....	74.6	.5	.3	16.5	7.5	.6	455
Mulberry *a*	....	84.7	.4	....	14.3		.6	280
Muskmelons	50.0	89.5	.6	....	7.2	2.1	.6	185
Nectarines	6.6	82.9	.6	....	15.9		.6	305
Olives	17.9	67.0	2.5	17.1	5.7	3.3	4.4	407
Oranges	27.0	86.9	.8	.2	11.6		.5	240
Peaches	18.0	89.4	.7	.1	5.8	3.6	.4	190
Pears	10.0	80.9	1.0	.5	15.7	1.5	.4	163
Persimmons	*b*25.0	66.1	.8	.7	29.7	1.8	.9	630
Persimmons (Japanese)	24.0	80.2	1.4	.6	15.1	2.1	.6	174
Pineapples	40.0	89.3	.4	.3	9.3	.4	.3	200
Plums	5.0	78.4	1.0	....	20.1		.5	395
Pomegranates	*b*30.0	76.8	1.5	1.6	16.8	2.7	.6	460
Prunes	5.8	79.6	.9	....	18.9		.6	370
Raspberries (red)	....	85.8	1.0	....	9.7	2.9	.6	255
Raspberries (black)	....	84.1	1.7	1.0	12.6		.6	310
Red bilberry	....	89.6	.1	*b*.3	3.8	*b*6.0	.2	190
Rhubarb stalks	40.0	94.4	.6	.7	2.5	1.1	.7	105
Roselle calyx	....	86.5	2.1	.3	10.3		.8	235
Roselle pod	....	84.0	1.7	1.0	12.2		1.1	290
Sapodilla *a*	*b*40.0	77.9	.5	1.6	16.6	2.8	.6	425
Scarlet haws	20.0	75.8	2.0	.7	18.6	2.1	.8	212
Strawberries	5.0	90.4	1.0	.6	6.0	1.4	.6	180
Surinam cherry	....	85.0	.4	....	13.9		.7	260
Watermelons	59.4	92.4	.4	.2	6.7		.3	140
Whortleberries	....	82.4	.7	3.0	10.3	3.2	.4	390
Dried Fruits								
Apples	....	26.1	1.6	2.2	62.0	6.1	2.0	1,350
Apricots	....	29.4	4.7	1.0	62.5		2.4	1,290
Bananas *a*	....	29.2	5.3	2.3	55.8	2.1	5.3	1,240
Banana flour	....	9.7	3.1	.5	83.4	.7	2.6	1,610
Citrons	....	19.0	.5	1.5	78.1		.9	1,525
Dates	10.0	15.4	2.1	2.8	74.6	3.8	1.3	1,615
Figs	....	18.8	4.3	.3	68.0	6.2	2.4	1,475
Pears	....	16.5	2.8	5.4	66.0	6.9	2.4	1,635

a European analysis. *b* Assumed. *c* Including 3.5 per cent skin and seeds.

Table I—Continued

Kind of Fruit	Refuse	Edible Portion						
		Water	Protein	Ether Extract	Carbohydrates		Ash	Fuel value per pound
					Nitrogen-free extract	Crude Fiber		
Dried Fruits—Continued	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
Prunes	15.0	22.3	2.1	....	71.2	2.1	2.3	1,400
Raisins	10.0	14.6	2.6	3.3	73.6	2.5	3.4	1,605
Raspberries	....	8.1	7.3	1.8	80.2		2.6	1,705
St. John's bread	....	*b*17.3	5.7	1.1	67.0	6.4	2.5	1,450
Zante currants (English currants)	....	17.2	2.4	1.7	71.2	3.0	4.5	1,495
Canned Fruits, Preserves, Jellies, Etc.								
Crab apples (canned)	....	42.4	.3	2.4	54.4		.5	1,120
Apple sauce	....	61.1	.2	.8	37.2		.7	730
Apricots (canned)	....	81.4	.9	....	17.3		.4	340
Apricot sauce	....	45.2	1.9	1.3	48.8		2.8	1,000
Blackberries (canned)	....	40.0	.8	2.1	56.4		.7	1,150
Blueberries (canned)	....	85.6	.6	.6	12.8		.4	275
Cherries (canned)	....	77.2	1.1	.1	21.1		.5	415
Cherry jelly	....	21.0	1.1	....	77.2		.7	1,455
Figs, stewed	....	56.5	1.2	0.3	40.9		1.1	785
Grape butter	....	36.7	1.2	.1	58.5		3.5	1,115
Olives, green, pickled	27.0	58.0	1.1	27.6	11.6		1.7	1,400
Olives, ripe, pickled	19.0	64.7	1.7	25.9	4.3		3.4	1,305
Orange marmalade	....	14.5	.6	.1	84.5		.3	1,565
Peaches (canned)	....	88.1	.7	.1	10.8		.3	230
Pears (canned)	....	81.1	.3	.3	18.0		.3	355
Pineapples canned)	....	61.8	.4	.7	36.4		.7	715
Prunes, stewed	....	76.6	.5	.1	22.3		.5	430
Strawberries, stewed	....	74.8	.7	....	24.0		.5	460
Angelica stalks (candied)	....	10.4	.1	.1	87.3	1.5	.6	1,550
Apricots (candied)	....	14.4	.7	.1	83.0	1.1	.7	1,445
Cherries (candied)	....	12.1	.5	.2	86.1	.5	.6	1,455
Citron (candied)	....	18.2	.1	.1	77.6	1.0	3.0	1,380
Ginger root (candied)	....	12.3	.3	.2	86.1	.7	.4	1,530
Fruit Products								
Olive oil	....	....	....	100.0	....	....	....	4,085
Raspberry juice	....	49.3	.5	....	*a*49.9	....	.3	935
Unfermented grape juice	....	92.2	.2	*b*.5	6.9	....	.2	150
Other Foods for Comparison								
Cabbage	15.0	91.5	1.6	.3	4.5	1.1	1.0	145
Potatoes	20.0	78.3	2.2	.1	18.0	.4	1.0	385
Wheat flour, high grade	....	12.0	11.4	1.0	74.8	.3	.5	1,650
Corn meal, bolted	....	12.5	9.2	1.9	74.4	1.0	1.0	1,655
White bread	....	35.3	9.2	1.3	52.6	.5	.5	1,215
Beans, dried	....	12.6	22.5	1.8	55.2	4.4	3.5	1,605
Honey	....	18.2	.4	....	81.2	....	.2	1,520
Sugar, granulated	....	....	....	....	100.0	....	....	1,860
Butter	....	11.0	1.0	85.0	....	....	3.0	3,605

a Probably contained added sugar. *b* European analysis.

Most fruits, like other classes of foods, contain more or less material, such as pits, skin, etc., which is inedible. When such portions are removed a larger or smaller part of the edible material is almost always of necessity removed also, and is spoken of as "waste." In reporting analyses the amounts of inedible material and waste are grouped together under the heading "refuse." As may be seen from the above table, the proportion of refuse in fruits varies within rather wide limits. Thus, of pears it constitutes on an average 10 per cent of the total fruit, peaches 18 per cent, apples and grapes 25 per cent, and bananas 35 per cent, while in the case of raspberries and blackberries there is no refuse and the whole fruit can be eaten.

The analytical data quoted above show that fresh fruits are in general dilute foods—that is, the proportion of water which they contain is large, compared with the total amount of nutritive material. It has been suggested that fruits containing 80 per cent or more of water be classed as flavor fruits and those with less than 80 per cent as food fruits. As